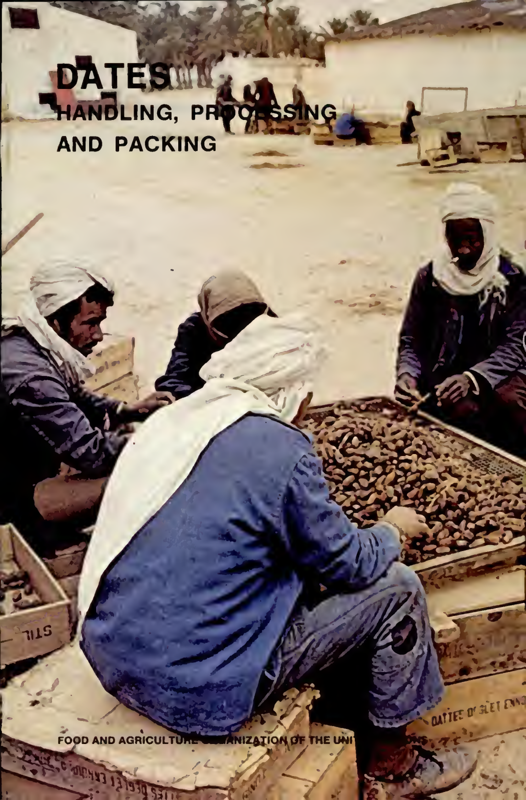

DATES

HANDLING, PROCESSING AND PACKING

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

DATES - HANDLING, PROCESSING AND PACKING

This One
JS8Y-81A-2QN3

FAO Plant Production and Protection Series *No. 13*
FAO Agricultural Development Paper *No. 72*

DATES
HANDLING, PROCESSING AND PACKING

Prepared by

V. H. W. DOWSON

FAO Consultant and Date Expert

and

A. ATEN

Rural Industries Specialist
Agricultural Engineering Branch
Land and Water Development Division

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome 1962

First printing 1962
Second printing 1978

P-17
ISBN 92-5-100456-0

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Printed in Italy

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FOREWORD

A basic aim of the Food and Agriculture Organization of the United Nations is to encourage greater production and better distribution of food and to improve nutritional standards, especially in the less developed regions. Since 1945, when FAO was established, much progress has been made toward this end through the work of international, multilateral, bilateral and national organizations. FAO has taken a leading part in this work.

But, despite all that has been done, the problem of hunger remains unsolved and, indeed, threatens to grow larger. A recent FAO study shows that between 300 and 500 million people suffer from actual lack of food and between one third and one half of the world's population of about 3,000 million from varying degrees of malnutrition. Unless drastic action is taken, more millions will join them in the coming years as the result of the rapid increase in world population. This is expected to double itself by the end of this century, when the total is likely to exceed 6,000 million.

It was because of the continuing nature of the hunger problem and the threat of its becoming worse in the next four decades that the Director-General of FAO, Dr. B. R. Sen, proposed the Freedom from Hunger Campaign which was launched on 1 July 1960. The Campaign, which is being supported by people in all countries as well as by the United Nations and all the Specialized Agencies and Member Governemts of FAO, is, in effect, a rededication to the objectives of the charter of FAO. In particular it seeks to focus world attention on the continuing problem of hunger and to create a climate of opinion which might lead to a massive attack on the problem on a global scale.

A vital part of the Campaign is therefore concerned with information and education – that is, spreading knowledge and understanding of the magnitude of the hunger problem and explaining what can be done to solve it. In this respect, every publication that deals with any aspect of the problem – technical, economic or social – is a contribution to the Campaign, and thus to the goals of FAO.

This Agricultural Development Paper comes into that category. It is intended primarily for agricultural officers and for those who are responsible for date improvement, handling, processing and packing programs. It is hoped that the material in this paper will also reach date growers, merchants and packers through the various national extension services.

The present paper is fully illustrated, to make it as useful as possible for educational purposes, particularly in countries where modern processing and packing facilities have only recently been introduced.

In countries where modern processing and packing houses are new features, the growers still have to learn how to harvest, handle, pack and transport their dates in such a way that they are acceptable to the packing house. Therefore, a great deal of information is included on field operations and other matters that are of concern to growers. Growers should not deliver at the packing house dates that are bruised, full of sand, infested with insects, that have lost their individual shape, or that have other defects that render them unsuitable for profitable processing and packing for the market.

From the chapters on "Composition and Ripening" and "Field Operations," the grower will realize that all the operations that lead to successful marketing begin in the gardens, whether the dates are marketed in the fresh *rutab* stage or in fancy packs.

It should be recognized that in date-growing regions there is an extensive regular daily harvest, handling and local trade in fresh *rutab* and ripe dates. In some places all the dates are consumed locally in the *rutab* stage, but as was realized at the First FAO International Technical Meeting on Date Production and Processing, which was held in Tripoli, Libya, from 5 to 11 December 1959, an increase in the trade of dates harvested in the *rutab* stage would be desirable in some places from an economic point of view. It would, therefore, be beneficial for the date industry and for the food supply in big cities if their handling and storage facilities for *rutab* dates were improved.

The methods and processes, including the necessary equipment and machinery which can be used advantageously in modern packing and processing establishments, are described in broad outline. It must be clearly recognized, however, that only good packing house hygiene and proper management can guarantee successful economic results for grower, packer and merchant.

To achieve success, in a country new to modern date processing and marketing, an educational campaign should be undertaken, directed toward growers, packers and merchants. Extension workers must fully understand the importance of improving the efficiency of all field operations, cutting down growing costs, and raising the quality of the crop.

There are modern books on food technology and a number of useful papers on particular aspects of the date industry, but there is no single publication which gives a general account of the various operations to which the date is subjected between harvesting and delivery from the packing house to the wholesaler. The present paper brings together the results of research, experience and observations made on dates, part of which can be found in various journals, and part of which does not appear to have been previously recorded.

Date consumption presents a strange paradox. In many parts of the world this fruit is considered a luxury and must compete with other fruits, sugars and confections. In the major date-growing regions, however, the date is considered the chief source of high-energy food. Nevertheless, even the people there are changing their food habits. Therefore, to assist the date grower in finding a market for his dates, it is necessary that research on other uses of dates, such as for syrup, for soft drinks, confectionery, etc., should be continued.

These matters are not included in the paper, but for those interested in gaining further information, a list of selected references is included.

The following have contributed information, sketches and photographs, and their co-operation is gratefully acknowledged:

Mumtaz Arif, Professor at the University of Libya and formerly Dean of the College of Agriculture, Baghdad, Iraq.

W. H. Barreveld, FAO Date-Processing and By-Products Utilization Expert, FAO Mission, Tripoli, Libya.

G. F. Brown, Senior Agriculturist, Aramco, Dhahran, Saudi Arabia.

T. C. Carlson, FAO Date Expert, formerly with FAO Missions in Saudi Arabia and Pakistan.

Mrs. Joy Dowson.

N. J. Copley, Director, Western Regional Research Laboratory, Albany, California, United States.

S. L. Galpin, FAO Marketing Expert, FAO Mission in Tripoli, Libya.

Abdul-Ameer Ghosum, former FAO fellow, now general technical superintendent, Date Association, Baghdad, Iraq.

M. Girard, Ingénieur des Services agricoles de l'arrondissement de Touggourt, Station expérimentale agricole d'El-Arfiane (par Djamaa), Sahara.

L. G. Jowett, Director of Marketing and Industries, Administration of Tripolitania, Tripoli, Libya.

G. D. Kapsiotis, formerly Date Technologist with FAO Mission in Iraq, now Food Technologist in Nutrition Division, FAO Headquarters, Rome.

Ramzi Khalidy, Assistant Professor of Subtropical Horticulture, American University of Beirut, Beirut, Lebanon.

Vincent P. Maier, Chemist, Fruit and Vegetable Chemistry Laboratory, United States Department of Agriculture, Pasadena, California, United States.

A. Marchal, Chef du Service de l'agriculture, Saint-Louis, Mauritania.

H. Martin, FAO Expert in Plant Protection, formerly with the FAO Mission in Libya, now with the FAO Mission in Iran.

Martin W. Miller, Assistant Professor of Food Science and Technology, University of California, College of Agriculture, Agricultural Experiment Station, Davis, California, United States.

P. Munier, Institut français de recherches fruitières d'outre-mer (IFAC), Paris, France.

Roy W. Nixon, Horticulturist, United States Date Field Station, Indio, California, United States.

Chanan Oppenheimer, Head, Division of Subtropical Horticulture, Ministry of Agriculture, Agricultural Research Station, Beit Dagan, Rehovot, Israel.

G. J. Piquer, FAO Regional Horticulturist, Cairo, United Arab Republic.

Z. Rapoport, Ministry of Agriculture, Department of Horticulture, Hakirya, Israel.

S. Steller, Ministry of Agriculture, Department of Horticulture, Hakirya Israel.

E. Swirski, Head, Department of Horticultural Pests, Agricultural Research Station, Beit Dagan, Rehovot, Israel.

Mrs. Z. Samisch, Head, Department of Food Technology, Agricultural Research Station, Rehovot, Israel.

P. Teisseire, Ingénieur en chef des Services agricoles, Chef de la Division de la protection des végétaux, Insectarium, Jardin d'essai, Algiers.

Frank H. Winter, FAO Date-Processing Expert, formerly with the FAO Mission in Iraq, now with the FAO Mission in the Sudan.

In addition, acknowledgments are due to a number of manufacturers who made available photographs and further details of their equipment and machinery.

CONTENTS

FOREWORD v

INTRODUCTION 1

Distribution of date palms 1
Production (1959) 2
Importance of the date 3

1. DESCRIPTION OF THE DATE 6

Name and botanical description 6
  Seedless dates 6
  The perianth 7
Fresh dates 9
Dried dates 10
Shape, size, weight, color and type 10
Varieties 12
  Origin and number of varieties 12
  The packer's choice 14
  Main variety in each country 14
  Main varieties packed in modern packing houses 14
  Differences between varieties of concern to the packer 15

2. COMPOSITION AND RIPENING 17

Date composition in each stage of ripening 19
  Main constituents 19
Stages in ripening 19
  "Kimri" 27
  "Khalaal" 27

- " Rutab " 28
- " Tamar " 29
- Arrested development 30

The date palm as potential sugar (syrup) producer 31

Sugars in dates 32
- Invert sugar, glucose and fructose 33
- Reducing and nonreducing sugar 34
- Type of sugar and the packer 36

Summary of names for stages in ripening of the date 41

Constituents 41
- Sugar and water 41
- Remaining constituents 44
- Cellulose, starch, etc. 44
- Tannin 45
- Pectin 46
- Constituents of particular food value 46
- Fat, acid, pigment, esters 47

Osmotic pressure 48

Methods of analysis 49
- Moisture and sugar 50
- Some constituents of the date pit 52

3. FIELD OPERATIONS 53

Harvesting 53
- Reaching the dates 53
- Detaching the dates 56
- Lowering the dates to the ground 58
- Collecting the dates from the ground 61
- Field containers 63

Field grading 65

Field pitting and capping 68
- Pitting 68
- Capping 69

Field skinning, slicing and pounding 73
- Skinning 73
- Slicing 73
- Pounding 74

- Field ripening and curing 74
  - Ripening "kimri" 76
  - Ripening "khalaal" 76
  - Simple spreading in the sun 79
  - Black sheds 79
  - Shrivel 81
  - Split dates 81
  - Ripening agents 82
  - Preservation in syrup 84
  - "Khalaal matbuukh" – Meaning of name and essentials of practice 84
  - Distribution of practice and names of product 85
  - Description of process 85
  - Cost, advantages and disadvantages 90
  - Ripening in jars 91
  - Curing "rutab" 93
  - Curing "tamar" 96
- Field fumigation 96
  - Bunch treatment 98
  - Method 98
  - Fumigant 101
- Field packing 102
  - Baskets 104
  - Skins 105
  - Jars 106
  - Packing methods by region 107
- Field storage 115
  - The bin 115
  - The jar 118
  - Storage of pressed dates 119
  - Sand pits 120
  - Open sheds 121
  - Shade cloth 121
- Field transport 122
  - Garden transport 122
  - Transport to market or packing house 124

4. PREPROCESSING 128

Preliminary packing-house operations 128
  Receipt of dates 128
  Washing and repair of lug boxes 134
  Stripping bunches 134
  Storage 135
Fumigation 138
  Preliminary 138
  Definition 139
  Object 139
  Advantages 139
  History 141
  Frequency 142
Fumigants 144
  Desirable qualities 148
  Factors affecting efficacy 148
  Fumigants 150
  Sulfur dioxide 150
  Carbon disulfide 152
  Hydrogen cyanide 152
  Carboxide 152
  ECM or chlorasol 152
  Methyl bromide 152
  Ethyl formate 154
  Indicators 155
Chambers 155
  Site 155
  Size 156
  Shape 157
  Construction 158
  Circulating fans 159
  Exhaust fans 161
  Heating 164
  Fumigant supply 164
Method 166
  Vacuum *versus* atmospheric 166
  Application 167

- Results 168
- Safety precautions 170
- Legislation 172
- Other practices for controlling insect infestation 174
- Grading 174
  - Grading for maturity 175
  - Grading for size, color, etc. 179
  - Elimination of culls and refuse 182
- Insects and mites damaging dates 184
  - Insecta 184
  - Acarina (Spiders, etc.) 190
- Position of grading in chain of packing-house operations 191
  - Grading machines 193
  - Grading from a moving belt and grading from a box on a wire tray 201
  - Cost 203
- Standards 203
  - Iraq 204
  - United States of America 206
  - Algeria and Tunisia 208
- Cleaning 209
  - The shaker tray 210
  - Air cleaning 211
  - Washing 211
  - Drying after washing 216
- Pitting 216
  - Hand pitting 217
  - Hand-operated date pitter 217
  - The masher pitter 221
  - The whole date pitters 223
  - The stickiness of dates 223

5. PROCESSING 224

- Regions of different processing methods 224
  - Iraq 225
  - Southern Tunisia and northern Sahara 225
  - United States of America 225

- The Sudan, the south of the United Arab Republic and southern Libya 225
- The north of the United Arab Republic and northern Libya 226
- The shores of southern Arabia and the Persian Gulf 226

Heat 226
- Definition 226
- Historical 227
- Advantages 227
- Uses 228
- Trays 230
- Maturation 230
- Curing 234
- Pasteurization 234

Dehydration 238
- Rate of drying 240
- Drying ratio 240
- Moisture ratio 241
- Dehydrators 242

Freezing 248

Hydration 249
- Absorption of moisture from the air 249
- Transfer of moisture from one date to another 250
- Cold water 250
- Hot water 252
- Steam 252
- Vacuum 253

Glazing 256

Ripening agents 257

Preservatives 259

6. PACKING 261

History 261
- Iraq 261
- North Africa 262
- United States of America 262

The packing house 263
- Advantages of modern packing houses 265
- Siting 265

Size 269
Design 271
Units 271
Windows 274
Electricity 275
Floor 278
Walls 278
Air 278
Water 278
Fire 279
Costs 279
Miscellaneous expendable stores 286
Need for economy in packing-house operations 286
Sales organization and advertisement 287

APPENDIXES

1. *p*H value 288
2. Comparative tables of sucrose and other contents for palm juice (*Neera*), sugar cane juices, and the palm and sugar cane gurs 291
3A. Names of dates in their stages of development in different countries 292
3B. Names of parts of the date palm in English, French, and in four languages used north of Lake Chad 294
4. Equilibrium moisture content curve 296
5. Moisture determination in dates by means of a refractometer 300
6. Moisture determination in dates (Bidwell and Sterling method) 302
7. Moisture determination in dates (Vacuum oven method) 305
8. Analysis of sugar in dates 308
9. Relationship between specific gravity and maturity in Haiyaani dates in the *khalaal* stage 315
10. Analytical data of some of the constituents of the date pit 316
11. Graphical representation of the activities in a date-packing house 318
12. United States standards for grades of dates 322
13. Standards for grades of Algerian dates to be exported 338
14. Regulations for the standardization of Tunisian dates to be exported 343
15. Explanation of words used in the date industry 350
LIST OF REFERENCES 368
GLOSSARY OF BIBLIOGRAPHICAL TITLES 390

LIST OF ILLUSTRATIONS

Figure

1. New door made of date palm planks. Ghadames, Libya
2. Underside of roof, beams of which are made of date palm trunks. Et-Taaj, Kufra, Libya 4
3. Longitudinal section of date, showing its parts 7
4. A large part of the date crop is marketed fresh as *khalaal*. Fruit market, Tripoli, Libya 8
5. Hammuuri dates growing on bunch in garden of Ali el-Jabali at Suuq el-Juma, Libya 9
6. Pressing dates barefoot 18
7. Stages in the ripening of a date of the Beiyuudhi variety, Tripoli, Libya 20-25
8. Stages in the development of the *abul khusheim* condition in the Hallaawi date 26
9. Normal development of Hallaawi. Basra, Iraq 26
10. View of laboratory at the Date-Processing Research Station, Tripoli, Libya 49
11. A hand refractometer which can be used to determine total solids and moisture content of dates. Rochester, New York, United States 50
12. Brabender rapid moisture tester. Duisburg-on-Rhine, Germany 51
13. Footholds are scooped out of the trunk to assist climbing. Madwein, Libya 54
14. Simple climbing belt and axe for pruning, as used ar Zaawiya, Libya 55
15. Picking platforms as used in California, United States 57
16. The 40-foot light ladder in use in California, United States 57
17. Shaking the bunch of the Bikraari variety by hand. Zliten, Libya 59
18. Cutting the whole bunch. Baraak, Libya 59
19. The bunch in mid-air. Baraak, Libya 60
20. The bunch on the ground. Baraak, Libya 60
21. Lowering bunch on rope. Baja California, Mexico 62
22. Lowering dates on crutched stick or *maglas*. Amaara, Iraq 62
23. Bunches of Aukali thrown from palm on the sand. Idri, Libya 63
24. Istaamraan (Sayir) thrown on palm leaflet mats, supported by bamboo rods at either side. Basra, Iraq 64
25. The dates are tipped from mat into quarter *mann:* boxes. Basra, Iraq 65
26. In Libya, similar baskets, but made of woven esparto grass, are sometimes joined together to make panniers. Zliten market, Libya 66
27. Jute sacks for dry dates in Tripoli market, Libya 66
28. Sack for hard, dry, desert dates, made of wool, mohair, and camel hair. Maraada, Libya 66

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Figure

29. Field grading of Zahdi. Baghdad, Iraq 67
30. Transport of dates on the bunch to the packing house by cart. Tunisia 68
31. Inversion of dates during growth 72
32. Drying of *rutab* under glass in rural packing house. United Arab Republic 78
33. Drying *rutab* on roof in rural packing house. Chicken-wire cage keeps off sparrows. United Arab Republic 78
34. Drying dates on mats. United Arab Republic 80
35. Beiyuudhi, Taabuuni and Bikraari pitted halves drying on circular mats (called *badaaraat*) on sand. Zliten, Libya 80
36. Drying stands and trays, and agricultural overseer. Talesi Bagh, Muzaffargarh, West Pakistan 81
37. Split Bikraari halves, the commonest date on the Tripolitanian coast, Libya 83
38. Bikraari sun-dried, pitted halves. Tripolitanian coast, Libya 83
39. The fireplace and chimney of the stove used for cooking hard, yellow dates (*khalaal*) to turn them into hard, dry, long-keeping dates (*khalaal matbuukh* or *saluuq*). Baatina coast, Muscat 85
40. Cooking Bureim *khalaal* to make *khalaal matbuukh*. Nahar Dihchaan, Iraq 86
41. *Khalaal matbuukh*. Khorramshahr, Iran 87
42. Dates maturing in jars. Sudan 91
43. The softer desert dates are stored in earthenware jars. Ghadames, Libya 93
44. Dehydrator, open, cold-end type. Government Date-Packing House, Tripoli, Libya 95
45. Taasfirt dates removed from pit in sand. Umm el-Hammaam, Fezzan, Libya 97
46. Putting sand snakes round stack of date boxes before fumigation with methyl bromide. Date Association Packing House, Baghdad, Iraq 99
47. Sketch of field fumigation box. Basra, Iraq 100
48. Mud fumigation chamber. Bouga, Sudan 101
49. Fastening door to mud fumigation chamber. Bouga, Sudan 101
50. The packers start their job young. Iran 103
51. Dry dates (Zahdi) in paper-lined sacks. Khorramshahr, Iran 103
52. Specially made baskets of uniform size and containing 100 kilograms of dates each were used for the school-feeding program in 1954. Experimental Date-Packing House, Tripoli, Libya 106
53. A mechanical press was used to press the dates into the baskets 106
54. In Makran, Pakistan, considerable use is made of the earthenware jar (*humb*) in which dates in syrup are preserved for home use and for export 108
55. The usual storage place in the Fezzan, Libya, is the sand pit or *matmar* 109
56. Aukali and Taasfirt dates removed from *matmar* (sand store). Ubaari, Fezzan, Libya 109
57. A field storeroom for Zahdi near Baghdad, Iraq 117
58. Nearer view of the same store 117
59. Inside the same store 118
60. Garden (and packing) boxes for transport of dates from palms to packing house on bank of creek. Khorramshahr, Iran 123
61. Transport by donkey in gardens. Baja California, Mexico 123
62. Box locally made of wood from boxes in which soap, cans of food, etc., have been imported. Government Date-Packing House, Tripoli, Libya 125

Figure

63. Completed box, lined with kraft paper before the final pressing. Khorramshahr, Iran 125
64. Crates of date palm frond midribs for the transport of dates, more especially in fresh (*khalaal*) stage. United Arab Republic 126
65. The Baghdad Date-Packing House, with loading and unloading ramp of a convenient height 128
66. *Hashaf* (shrivelled dates), the spikelet of which has been partly torn from the main axis of the bunch. Basra, Iraq 129
67. Date-sampling machine. California, United States 130
68. Construction of a clamp truck 132
69. Clamp truck in operation. Tripoli, Libya 133
70. Box washer from side. California, United States 135
71. Box washer from end. California, United States 136
72. Stripping Daglat Nuur in Tunisian maturation shed from suspended hooks. Basra, Iraq 137
73. Packed cases of dates awaiting shipment. Basra, Iraq 138
74. Small quantity of dates on trays for box fumigation with carbon disulfide. Rural packing house, United Arab Republic 145
75. Fumigating box as used in rural packing house in the United Arab Republic 146
76. Postwar vacuum fumigating chambers under open shed and packed export cases of dates on trucks awaiting fumigation. Basra, Iraq 146
77. Nearer view of the vacuum fumigation chambers. Basra, Iraq 147
78. A vacuum fumigation unit, with horizontal cylinder mounted on a truck. Paris, France 147
79. Tarpaulins used in the Government Date-Packing House in Kareima, Merowe, Sudan, to cover dates in sacks fumigated outside the packing house 156
80. Constructional details of door of a fumigation chamber. Government Date-Packing House, Tripoli, Libya 160
81. Constructional details of exhaust fan on roof of fumigation chamber. Government Date-Packing House, Tripoli, Libya 162
82. A satisfactory exhaust fan for a fumigation chamber. California, United States 163
83. Fumigation with small can of methyl bromide. The open end of the copper tube is inside the fumigation chamber. The operator holds the can outside the chamber door. Date Association Packing House, Baghdad, Iraq 164
84. Detailed sketch of control room of fumigation chambers. Government Date-Packing House, Tripoli, Libya 165
85. Measuring amount of methyl bromide to be used by weight on portable platform scale. Date Association Packing House, Baghdad, Iraq 168
86. Measuring out liquid methyl bromide by volume in glass pressure cylinder before fumigating stack of date boxes. Date Association Packing House, Baghdad, Iraq 169
87. Piercing the 1-pound can of methyl bromide (under pressure) by means of special device which releases the gas only into the copper tube and then into chamber. Date Association Packing House, Baghdad, Iraq 169
88. Varietal differences: Istaamraan dates showing characteristic sharp line of demarcation between basal, unripe, *khalaal* half, and the apical, soft, ripe *rutab* half 176
89. Damage by birds. Basra, Iraq 183

Figure

90. Class for date infestation inspectors. Date Association Packing House, Baghdad, Iraq 183
91. " June drop. " Dry, small, immature dates 185
92. Undeveloped, brittle, Venetian-red dates into which the Lesser Date Moth larvae have eaten their way. Basra, Iraq 187
93. The web spun over the green dates by mites. Basra, Iraq 188
94. Grading. California, United States 192
95. Grading. Date Association Packing House, Baghdad, Iraq 192
96. Grading. Rural packing house, United Arab Republic 194
97. Simplified washing and grading unit for small packing operations. Indio, California, United States 195
98. Convenient packing table, Fresno, California, United States 195
99. Dump elevator in manufacturers' workshop. Pomona, California, United States 196
100. The dump elevator in use at the Government Date-Packing House, Tripoli, Libya 197
101. Elevator and washer. Fresno, California, United States 197
102. Elevator for raising dates for packing, pressing, or for other purposes. Fresno, California, United States 198
103. General view of packing line for ten packers. Elevators, supply belts, date-packing and weighing tables and removal belts in manufacturers' workshop, Pomona, California, United States 199
104. Supply belts and packing and weighing table, showing scale conveniently let into table. Pomona, California, United States 199
105. Belt conveyor distributor, showing three divisions. Indio, California, United States 200
106. Good lighting is necessary in a packing house. Date Association Packing House, Baghdad, Iraq 201
107. The first mechanical grader to be used in Basra, Iraq. End 1926 203
108. Cartons closed and window designed for the Experimental Date-Packing House, Tripoli, Libya 205
109. Meccan dates in cartons for pilgrims, packed in modern date-packing house set up temporarily by the Government and FAO expert in Jedda and transferred later to Mecca 205
110. The government inspector with his scales and records. California, United States 208
111. Shaker cleaner. Fresno, California, United States 211
112. Washing machine. Pomona, California, United States 212
113. Washing machine. Algeria. The dates are drained in chip baskets 212
114. Washing machine. Marseilles, France 213
115. Machine for drying dates by air blast after washing. Pomona, California, United States 213
116. Apparatus for automatic injection of small quantity of fungicide into each packet as it passes along conveyor belt. Fresno, California, United States 215
117. Packing line, showing fumold injector and scales. Fresno, California, United States 215
118. Details of a hand-operated date pitter 219
119. The California masher pitter. Fresno, California, United States 221

Figure

120. Battery of plunger-type date pitters. California, United States 222
121. Semiautomatic pitter. California, United States 222
122. Unloading of trays on which dates have been dehydrated. Government Date-Packing House, Tripoli, Libya 231
123. Tray washer; can wash and rinse up to 100 trays an hour. Gomersal, England 232
124. Four chambers, back to back in one block, for use as date dehydrators or pasteurizers. Marseilles, France 237
125. Processor-pasteurizer. Fresno, California, United States 238
126. Jar sterilizer for syrup and jarred dates. Rugby, England 239
127. The dehydrator in the Government Date-Packing House, Tripoli, Libya. Cold end 239
128. The dehydrator in the Government Date-Packing House, Tripoli, Libya. The hot end, with doors open 244
129. Diagrammatic vertical cross section of dehydrator. Government Date-Packing House, Tripoli, Libya 244
130. Loading the dehydrator by hand before the installation of the hydraulic loader. Government Date-Packing House, Tripoli, Libya 245
131. Wide-mouthed discharge valve for date-soaking vat. Marseilles, France 251
132. Dates hydrated by steam cooling off on trays outside hydration chamber. California, United States 252
133. Dates hydrated in cold water in experimental vacuum hydrator 255
134. Equipment for adding moisture to dates under vacuum. Government Date-Packing House, Kareima, Merowe, Sudan 255
135. Packing glove boxes. Tunisia 263
136. Date-Packing House in the Coachella Valley, California, United States 264
137. Packing cellulose film bags. The scales and funnel with liner. Government Date-Packing House, Kareima, Merowe, Sudan 266
138. The dates are weighed out. Government Date-Packing House, Kareima, Merowe, Sudan 266
139. The dates are tipped into the funnel. Government Date-Packing House, Kareima, Merowe, Sudan 266
140. The spout of the funnel is below the table. Government Date-Packing House, Kareima, Merowe, Sudan 267
141. The cellulose film bag is held under the spout and the dates fall into it. The bag is slid between the iron rods which close its mouth. Government Date-Packing House, Kareima, Merowe, Sudan 267
142. The hand heat sealer to seal the bags. Government Date-Packing House, Kareima, Merowe, Sudan 267
143. Rejects being emptied from trays made of local wood into a sack for resale. Government Date-Packing House, Kareima, Merowe, Sudan 268
144. Boxes ready for shipment 268
145. Two electric-operated ram presses for making Bikraari date block. Government Date-Packing House, Tripoli, Libya 270
146. Detailed picture of the presses shown in the previous figure 270
147. Wrapping pressed blocks of dates in cellulose film by hand and glueing on labels. Small rural date-packing house, United Arab Republic 272
148. Hand-operated machine for making tray cartons for dates. California, United States 272

Figure

149. Date-dicing (slicing) machine for cutting individual dates into slices. California, United States 273
150. Date mincer (grinder). Fresno, California, United States 274
151. Date-mincing machine. Date-Packing House, Tripoli, Libya 275
152. Mincing Taabuuni dates with hand mincer for half cubes for cellophane-wrapped trays. Experimental Date-Packing House, Tripoli, Libya 276
153. Hand press for small packs. Fresno, California, United States 276
154. Steel hand press for small blocks of dates. Small rural date-packing house, United Arab Republic 277
155. Cellulose film-wrapping machine in production line. Date Association Packing House, Baghdad, Iraq 278
156. Partly automatic wrapping and heat-sealing machine. Suitable for small output of dates in cartons wrapped in cellulose film. California, United States 279
157. A transportable scale for boxes and bulk packs 282
158. A small scale for weighing loose dates for bag or tray pack. Birmingham, England 282
159. A quick-acting scale for checking the weight of small packs. Birmingham, England 283
160. Roller conveyers for use in packing house. Fresno, California, United States 283
161. Hand stapler for making and closing fibreboard cases. Copenhagen, Denmark 284
162. Automatic stapler for making and closing fibreboard cases. Copenhagen, Denmark 284

Graph

1. Scale indicating the pH value of acid, neutral and alkaline solutions 288
2. Equilibrium moisture content curve for Bikraari dates (20° C.) 295
3. Equipment for the determination of moisture in dates and other agricultural products 301
4. Drying curves of two samples of dates at 65° and 70° C. 304
5. Analysis of sugar in dates 307
6. Storage requirements in the date-packing house 317
7. Example of graphical interpretation of activities in a 500-ton date-packing house 317

LIST OF TABLES

Table

1. Main changes in the composition of the Californian Daglat Nuur during development 19
2. Main changes in the composition of the Californian Barhi during development 28
3. Some changes taking place in the Daglat Nuur as it softens from the apex to the base 29
4. Differences between the composition of normal dates and those which have dry bases 31
5. Production figures for cane and beet sugar in quintals per hectare 32
6. Sugars and saccharine – Comparison of characteristics 35
7. Analysis of the sugars in stored samples of some well-known imported varieties of dates grown in the United States 37
8. Summary of Cook and Furr's statement 38
9. Sugar contents, in percentages, of very mature (*tamar*) Daglat Nuur dates 38
10. Analysis of the Californian Daglat Nuur 39
11. Analysis of Saiidi (*tamar*) dates in Cyrenaica (Libya) 39
12. Analysis of the Bikraari sun-dried dates from northern Tripolitania (Libya) 40
13. Analysis of the Hallaawi date from Iraq 40
14. Main changes in the composition of Zaghluul dates (United Arab Republic) at different stages of growth 42
15. Analysis of Zaghluul dates (United Arab Republic) at the edible stage 42
16. Water content of some Algerian dates 43
17. Different names for the cap. 70
18. Proportion of Fezzani dates without caps to those with adherent caps, by varieties, as received at Government Date-Packing House, Tripoli, 1957 season 71
19. Weight of *khalaal matbuukh* 88
20. Time taken to pit one box of *khalaal* 89
21. Time taken to pit 10 kilograms of *khalaal* 89
22. Fumigants commonly used for dates 151
23. Fumigants tried experimentally but little or not used commercially 151
24. Suggested classification of ripening stages, excluding those of Daglat Nuur variety and hard dates 178
25. Stages in the ripening of the Daglat Nuur date 180-181
26. Summary of temperatures recommended by various authorities for the artificial maturation of dates 233

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Table

27. Rapidity in drying dates by using a batch-type dehydrator heated by steam coils 240
28. Relation between moisture content expressed as T (parts of water per part of bone-dry matter) and as percentage on wet basis 243
29. Percentage of total gain in weight of dry Daglat Nuur dates (14 percent moisture) in humid air 249
30. Percentage of gain in weight of dry Daglat Nuur dates (14 percent moisture) in humid cold storage at 1° C. (34° F.) 250
31. Cost per pound for plants packing varying percentages of dates in retail packages, 1956-57 280

INTRODUCTION

The purpose of this work is to describe the operations to which the date is subjected at its various stages on the way from grower to wholesaler. For the better understanding of the whole, short preliminary notes on the date industry generally and on its status have been given. The composition of dates, and the changes in them that constitute ripening, have received somewhat fuller attention, because the better they are understood, the more intelligently the processor can treat his dates. Some account has also been given of varieties, because they differ widely from each other and need correspondingly different treatment during handling, processing, packing and storage.

There is a large vocabulary in Arabic of names for every part of the palm and of the date, for the different varieties, and for the date in its various stages of development. There are similar, though less rich vocabularies in Baluchi, Mahri, Makrani, Persian, Punjabi, Somali, Spanish, Teda, and perhaps in other languages. A number of words in Arabic and other languages as used in the date industry are given in appendix 15. In the text, the Arabic terms are those used in Iraq and adopted in the United States. They indicate the different, more obvious stages in the ripening of the date. Their equivalents do not exist in English.

Distribution of date palms

As far back as 4000 B. C., dates were already appreciated and commercially cultivated in what is known today as southern Iraq. In the Old World, the Near East and Africa are the regions where dates are grown commercially in large quantities. The date lands of Asia and Africa stretch from the Indus valley in the east to the Atlantic in the west. In Asia, the northern limit of date palm cultivation is about 32° north in the Indus valley. The date frontier then follows the southern edge of the Turko-

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Perso-Afghan mountain mass till it reaches about 35° north in Iraq and then turns southwest along a line represented by the I.P.C. Kirkuk-Haifa oil pipe, till it meets the Mediterranean at the Gulf of Gaza. It then follows the coast as far as Tunisia, and skirts the southern edge of the Atlas to the Atlantic.

The southern limit of the date lands in the Sahara is the 17th north parallel. It falls south to 15° north in the Sudan, then follows the coast of the Red Sea and the Gulf of Aden, dropping to about 10° north to take in the northern part of Somalia and Socotra. The line of southern limit then follows the south coast of Arabia and Makran (Pakistan) to the mouth of the Indus. It overlaps the northern limit of the duum palm (*Hyphaene*) by 5°.

The only commercial groves in Europe are those at Elche and Orihuela in Spain.

In the New World, there are important recent plantings of date palms in southern California at about 33° north, and others less recent and less important in the Lower California peninsula of Mexico, 6° or 7° further south.

There are a few unimportant recent plantings in Peru, Brazil, Argentina, Nama Land Territory (South Africa), and in the Australian desert in Queensland and in the Northern Territory. There are also some date palms in Cyprus, Ethiopia and Tanganyika.

Outside the limits defined above, and where the winters are not too cold for it, the date palm will grow but will not fruit properly.

The date palm does not grow in China, and the occasional references to candied Chinese dates in consular reports refer to the candied jujubes (*Zizyphus*).

Production (1959)

The main producing countries in the world are Iraq, Saudi Arabia, Iran, United Arab Republic, Algeria and Pakistan.

Dates are also produced in large quantities in Morocco, Libya, Tunisia, Sudan, Muscat and Oman, the Aden Protectorate, the United States, Bahrein and Mauritania, and in small quantities in Spain, Chad, Mexico, Yemen, Israel and Somalia. The world production of dates amounts to probably over 1,200,000 metric tons and the number of date palms in the world can scarcely be less than about 80 million.

The chief markets for the dates of Iraq and Iran are in Asia, although some high-quality Iraqi dates are shipped to the United States and to Europe.

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The dates produced in Algeria and Tunisia, on the other hand, are marketed mostly in continental Europe.

The Sudani dates mainly go to the United Arab Republic.

There is some doubt about the figure of 20,000 metric tons exported to Syria. They may be used there, but it is also possible that a large part is re-exported.

The world's trade in dates between countries must amount to over 300,000 metric tons. Most of this quantity is carried by ship from Basra, but an increasing part of the Iraqi export goes by truck and train across the desert to the Mediterranean. Of the quantity shipped from Basra, probably nearly half goes by dhow to Pakistan and India and along the southern shore of Arabia to East Africa.

Importance of the date

If the amount of the world production of dates, as estimated above, is accepted as a reasonable estimate, then the cash value of the annual crop could hardly be less than £12,000,000 (U. S. $33,600,000). The value of a kilogram of dates in the garden has been estimated at £0.010 (U. S. $0.028). Perhaps 200,000 families, or 1,000,000 persons, are supported entirely by date cultivation. To this number must be added the number of people who make their living by processing, packing, transporting and selling the dates, and making packing materials for them. This number must also be large, because the difference between the price paid to the grower and that paid by the consumer may be from 100 percent to as much as 1,000 percent of the original price.

The date palm is valuable to the grower not only because of the dates it bears, but also because it provides several of his other requirements. From the trunk are built the walls, rafters, doors (Figure 1), shutters and stairs of houses. The fronds are also used for the construction of complete houses, for fences, for roofs (Figure 2), for crates, chicken coops, bedsteads, boats and fuel. The frond bases are used for fuel and as floats for fishing nets. From the leaflets are woven mats and baskets, including the kind used for packing dates. With the fiber from round the heart of the palm rope is made and pillows and mattresses stuffed. Under the name of *crin végétal* or *crina*, the fiber from the leaflets is used for stuffing upholstered furniture. The sap is drunk either fresh or fermented, and from it sucrose sugar can be made. Finally, one of the most important functions of the date palm is to provide shade from the

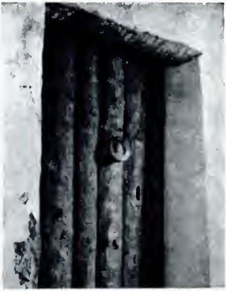

FIGURE 1. – New door made of date palm planks. They are often sewn together with camels-hide thongs and no nails are used. Ghadames, Libya.

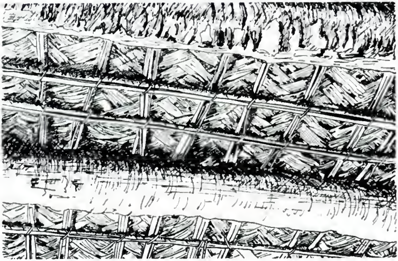

FIGURE 2. – Underside of roof, beams of which are made of date palm trunks. Above them are midribs of date palm fronds which support the rush mats, over which is plastered a layer of mud. Et-Taaj, Kufra, Libya.

(Courtesy Mrs. Joy Dowson)

sun and protection from the wind for the crops growing below them, for example, the citrus and truck crops of Iraq and the Sudan. In many places in the Sahara and in Arabia man is able to sustain himself against the inclemency of the climate only by the protection of his palms.

A large part of the date crop of the world never finds its way into trade but is eaten by the cultivator, by his family, and by his animals. It may be mentioned here that dates alone can uphold life for a long time. Some information on the composition of the date will be found in chapter 2.

Finally, in considering the importance of the date palm in the countries where it grows, it is to be noted that, like the betel nut palm among the Hindus, and the coconut palm in the Far East, it occupies a special place in the affection of those who cultivate it. The 17 references to the palm in the Koran all refer to it with respect; and the Prophet of Islam enjoined his followers to honor it, calling it their aunt.

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1. DESCRIPTION OF THE DATE

Name and botanical description

The systematic, botanical name of the date palm is *Phoenix dactylifera* L. Of the genus *Phoenix*, Blatter (1926) states there are about 12 species. One of these is the *Phoenix sylvestris* Roxb. of India, which is there usually called the wild date palm, but which in the literature is sometimes more briefly and loosely referred to as the date palm. It is, therefore, to be borne in mind that in reports of sugar production from date palms in India it is usually *P. sylvestris* that is meant, not *P. dactylifera.*

The only other species that needs to be mentioned here is *P. canariensis* Hort., common on the Riviera and sometimes mistaken for the date palm. It has, however, a stouter stem and its fruit is very small.

The date is a berry. The flower has three carpels but, on pollination, only one develops and two abort. The fruit is usually more or less oblong or ellipsoidal in shape: Figure 3 shows its parts in detail in longitudinal section. The seed, or pit, or stone, is bony and cigar-shaped, slightly pointed at the ends, about three times as long as it is broad, from gray to brown in color, with a small embryo. The date seed is unusual, in that the food material for the growing embryo is stored not as starch, as it is, for example, in the maize seed, but as cellulose.

SEEDLESS DATES

There is one variety of date that is seedless, the Biidandalu or Haseku of Shahdad near Kerman in Iran. The date is very small, measuring only 26 x 18 millimeters, but is otherwise normal, develops into the final, *tamar* stage, and is of good quality. This seedless date is not to be confused with the common, unpollinated date, which also has no, or an imperfect, seed but which never develops beyond the *khalaal* (the hard, glossy, yellow or red) stage.

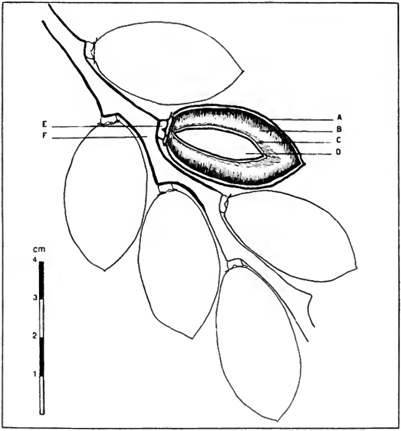

FIGURE 3. – Longitudinal section of date, showing its parts: (*a*) epicarp, skin; (*b*) mesocarp, flesh; (*c*) endocarp, white, papery envelope of seed; (*d*) seed, pit or stone; (*e*) perianth, calyx, or in the trade "cap"; (*f*) stalk or spikelet. The heavily shaded outer part of the flesh represents that part which has been almost entirely converted to sugar. The lighter part of the flesh represents the "rag," the more fibrous part, consisting chiefly of cellulose not yet converted to sugar. The lighter shading round the seed represents the hollow in the rag in which it lies.

(Courtesy Mrs. Joy Dowson)

THE PERIANTH

Dates grow on a bunch (Figure 4). The bunch consists of a main axis, which may be 4 to 7 centimeters thick. From this axis originate stalks (spikelets), which may be from 10 centimeters to a meter or more in length.

The dates, from 2 or 3 to 50 or 60, are attached by their perianths directly to the stalk. The perianth is the enlarged, dried, hardened remains of the calyx of three sepals and of the corolla of three petals. In the trade this perianth is commonly called a calyx and machines for removing it from the date are known as decalyxers.

The base of the perianth is joined directly to the stalk and the base of the date is joined directly to the perianth. The most readily observable ligaments attaching the date to the perianth are those that terminate at the base of the pit. When the date is in its moist stage, it may frequently be pulled off the bunch, leaving its pit still attached to the perianth and the stalk. At other times the pit may come away with the date, and as yet others, the perianth also comes away with the date. The degree of adhesion of the perianth to the date depends partly on the stage of maturity it has reached, but more on its variety.

The matter will be discussed more fully later on. It may be noted, however, that it makes a difference to the packer whether his dates have perianths or not.

Figure 4. – A large part of the date crop is marketed fresh as ***khalaal***. Fruit market, Tripoli, Libya.

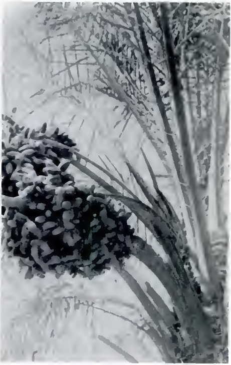

FIGURE 5. – Hammuuri dates growing on bunch in garden of Ali el-Jabali at Suuq el-Juma, Libya.

Fresh dates

Fresh (*khalaal*) dates are hardly known outside the districts where they grow, but dried (*tamar*) dates have been carried over much of the world since ancient times. Chaucer and Shakespeare mention them, and cured dates were among the cargoes for the ships of the East India Company from the beginning of the seventeenth century.

When ready for eating in the fresh stage, the date is at its greatest size and usually contains as much sugar as it ever will. It is generally only slightly astringent, is hard, and has a shiny, bright yellow, chrome yellow, pale rose or deep rose skin. It is juicy and fibrous but not sour. Europeans do not like fresh (*khalaal*) dates, finding them too fibrous, flavorless and sometines too astringent; but the people who live where dates are grown and who are mostly unaccustomed to good apples, pears and plums, every summer await with eagerness the arrival of fresh dates on the market (Figure 5).

Dried dates

In the marginal date lands, such as the coast of Libya, much of the crop never ripens further; but, where the heat is great enough, the hard date softens, the fiber disappears, and the color usually becomes brown. In Lower Egypt, those dates that have not already been eaten in the hard, fresh stage must be eaten as soon as they soften, for the heat is insufficient to dry them down before they start to ferment; but, in the hotter date lands, the soft fruit dries to the consistency of a soft prune. It is then no longer perishable, and is packed for export all over the world.

Shape, size, weight, color and type

As stated above, the date is generally oblong or ellipsoidal in shape, but some dates are spherical, some are long and tapering, others are like a cylinder, almost as wide as they are long. There are still others that are pentagonal in vertical section, the base corresponding with one of the sides of the pentagon and the tip with its opposite angle. Usually the base is flattened and the tip is pointed. Variations in size and weight are shown below.

Date	*Minimum*	*Maximum*	*Average*
length (mm.)	18	110[1]	40
width "	8	32	20
Pit			
length (mm.)	13	36	25
width "	6	11	8
Date including pit			
weight (g.)	2	60	7
Pit			
weight (g.)	0.7	4	1
Pit to flesh plus pit (%)	35	9	14

---

[1] Mr. Codekas of the Coachella Valley in California states that there is a seedling palm there which regularly produces dates as long as this.

The greatest differences in size are between varieties but, within a given variety, the longer dimensions and the heavier weights are for the dates in the *khalaal* stage, and the shorter dimensions and the lighter weights for the dates in the *tamar* or final dried stage.

The color of dates in the fresh stage has been mentioned. The color of the dried dates is generally brown. More often than not, this brown is a reddish brown like that of mahogany, but it may be almost anything from buff to black, according to variety, soil and treatment.

Slade in 1906 first showed that dates were of two types, the sucrose one (nonreducing sugar type) and the reducing sugar type. The distinction is important to the packer, because the two kinds need different processing treatments (see " Sugars in Dates, " chapter 2).

Dates may also be classified according to their usual consistency into soft (or wet), semidry and dry.

The following definitions, which are rough and overlap each other to a certain extent, may be useful (see also section " Date Composition in each Stage of Ripening ").

Soft dates, such as Barhi and Khastaawi, are those which pass through a *rutab* stage and remain soft when they reach the *tamar* stage. These dates are mostly of the reducing sugar type. (For the terms *rutab*, *tamar*, etc., see chapter 2 and glossary.)

Semidry dates are those varieties which pass through a *rutab* stage but make a dryish *tamar*. The sugar is generally of the reducing type. Most dates are of this type.

Dry dates are those varieties which do not pass through a *rutab* stage. They are mostly of the sucrose type, as for example Badraiya or Daglat Beidha.

Dry dates in a humid climate may be soft, but sometimes these " bread " or " mummified " dates are so hard that they will rattle like stones in a tin can. The amount of irrigation also affects the consistency of the date flesh.

An example of the difficulty of deciding whether a date is a fresh fruit or a dried one arose a few years ago when the Ministry of Finance in France ruled that North African dates arriving in Marseilles were dried fruit, while the Customs Department continued to classify them as fresh fruit.

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Varieties

ORIGIN AND NUMBER OF VARIETIES

The date palm is dioecious, that is, there are both male and female palms, the former normally bearing only pollen and the latter normally only fruit. Dates grow in countries where until recently there has been no plant breeding in organized, permanent, horticultural institutions, and they have not a world-wide importance, such as, for example, the cotton crop. Because the reproductive cycle in the date palm takes as long as five to ten years, while wheat, for example, can have two generations in a year, no genetically pure strains of dates have ever been bred. Therefore, a pure line date seed does not exist. A date seed, however, falling on favorable soil will, if it happens to be a female, grow into a palm, which will bear dates of unpredictable qualities. The chances are many thousands to one against their resembling those of the mother. Moreover, it is exceedingly unlikely that the dates borne by the seedling will be any good at all, because the complicated combination of qualities that produce a good date is likely to occur only once in a very large number of fertilizations.

It follows that, although the normal method of reproduction of the cultivated date palm is by the planting of offshoots, yet, since dates are always falling on the ground and their seeds frequently germinate, unless such seedlings are uprooted by the cultivator, there is likely to be a succession of seedling palms growing up in the gardens. Occasionally, one of these bears good fruit, its offshoots are then planted out, and a new variety arises. As a result, in the long history of date culture, several thousand varieties have become established.

With reference to seedling dates, Roy W. Nixon of the United States Date Field Station, Indio, California, states:

" I cannot agree that ' the chances are many thousands to one against their resembling those (qualities) of its mother, ' or that ' it is exceedingly unlikely that the dates the seedling will bear will be *any good at all.* ' There are certainly very large odds against getting a seedling identical with the parent variety, but there are often strong resemblances of seedlings to the parent variety. By that it is meant that they possess some characters of leaf and/or fruit that suggest by looks or otherwise the parent variety. It is something that varies considerably among different varieties. This has been observed many years ago in checking on large blocks of seedlings of different varieties at the old Bard station near Yuma, and these early impressions have been confirmed in more detail by observations on seedlings grown in a breeding project during the last ten years. Seeds of about 35 different varieties have been planted and, although there have not been more than five to ten progeny of many of them, the resemblance to the mother variety is quite marked in some cases. The similarity of Barhee seedlings, for example, to the parent variety was quite striking both in palm and fruit, the latter having the same color, shape, taste and, with one exception, a lack of stringency in the khalaal.

" The phrase stressed in the sentence quoted above is what makes it too strong in my opinion. ' Good ' depends on the point of view. It is indeed exceedingly unlikely that a seedling date will bear fruit equal to that of any one of the 40 or 50 world's best as proven through centuries, but that is not to say that the fruit will not be ' any good at all. ' It depends on what variety is planted. There is a very good chance of getting a date that will be satisfactory for home consumption or local use. But of course it takes a very long, long time to learn whether a seedling is equal or superior to any existing variety. I would say that we have at least a half dozen new varieties that originated from seeds planted nearly 50 years ago in Coachella and Imperial Valleys and that are definitely superior to 90 percent of the varieties that we imported from the Old World (e. g., " Empress, " " Honey, " " Haziz, " " Amber Queen, " " Blonde Beauty " and " Lindy ").

" You are right in discouraging the planting of date seeds in any of the proven date countries of the Old World, except for experimental purposes. But for *marginal* areas elsewhere, I would definitely recommend the planting of seeds of selected varieties. Marginal areas cannot hope to put dates on the world market in competition with countries like Iraq, so there isn't the immediate necessity for a uniform type and the variation from seeds increases the chances of getting types that are somewhat adapted to local conditions. Theoretically, it might be desirable to get offshoots from marginal localities in the Old World for trial in marginal localities elsewhere, but there are serious economic and political difficulties, and the entomological and pathological wisdom of it is very questionable. "

Although, as stated above, Nixon would not recommend the commercial planting of date seeds in any of the proven date countries of the Old World, he is strongly of the opinion that every one of them would profit in the long run from a variety testing and breeding program.

THE PACKER'S CHOICE

The date packer, therefore, has a large number of types of dates to choose from. In practice, however, his choice is limited to perhaps a dozen varieties or less, for, in most places where dates are grown, one variety, possibly because it has been found best suited to its environment, predominates. The packer is further limited to those varieties that can be brought to the packing house without an uneconomic haul. All of these, however, may not be demanded by his market. Again, some may be too costly for him, and others may be more easily disposed of fresh in the local market than handled in a packing house.

MAIN VARIETY IN EACH COUNTRY

The main variety grown in each country or province where dates are grown in large quantities is given below.

Country or province	*Main variety*
Algeria	Ghars (Rhars)
Bahrein	Mirzubaan
United Arab Republic	Haiyaani
Hadhramaut (Aden Protectorate)	Hamraiya
Hasa (Saudi Arabia)	Ruzeiz
Iraq (north)	Zahdi
Iraq (south)	Istaamraan (Sayir)
Libya (north)	Bikraari
Libya (south)	Taasfirt
Muscat	Umm Silla
Mauritania	Tinterguel
Morocco	Bu Faguus
Sudan	Barakaawi
Tunisia	Fatiimi (Aliig)

MAIN VARIETIES PACKED IN MODERN PACKING HOUSES

The main varieties packed in modern packing houses are shown below.

Algeria	Daglat Nuur Ghars (Rhars)
Iraq, Baghdad	Zahdi Khastaawi

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Iraq, Basra	Istaamraan (Sayir)
	Hallaawi
	Khadhraawi
Libya	Bikraari (1955-57)
	Taasfirt (1958-60)
	Khadhrai
Tunisia·	Daglat Nuur
	Fatiimi (Aliig)
United States of America	Daglat Nuur
	Khadhraawi
	Zahdi
	Barhi
Saudi Arabia	Khulaas
	Khuneizi
	Ruzeiz
Sudan	Barakaawi
	Gundeila
	Bint Hamuuda
	Mishrig Wad Laggai
	Mishrig Wad Khatiib
Iran	Istaamraan (Sayir)
	Muzaafti
	Kabkaab
	Shahaani
	Mordasang

DIFFERENCES BETWEEN VARIETIES OF CONCERN TO THE PACKER

Dates of different varieties differ among themselves in many characteristics. The general characteristic which concerns the packer, namely composition, will be considered in the next chapter.

Although people claim to be able to distinguish dates by their flavors, when given various kinds of invert sugar dates as paste, they can no longer recognize them. Chemists have tried to isolate a date flavor but without success. What people mean by the flavor of a date is prob-

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ably a matter largely of sweetness and of consistency of the flesh. The Daglat Nuur of North Africa and the United States of America, however, is widely considered to have a distinctive flavor in the soft stage. It is also claimed that the Istaamraan (Sayir) from the extreme south of the Shatt el-Arab date belt in Iran and Iraq taste salty.

The best work on date varieties is that by Nixon (1950), who describes 159 of them.

2. COMPOSITION AND RIPENING

Dates have been cured and packed satisfactorily from time immemorial by rule of thumb and without the packers knowing their composition; but the usual old method of packing was by pressing the dried dates firmly into baskets by foot (Figure 6). In this kind of pack the air is almost all excluded and the dates keep well, although their moisture content may vary from low to moderately high. It is otherwise with the modern pack, where the dates are separate from each other and their moisture content must be known precisely. The modern packer should also know the type of sugar that predominates in a particular date, because the kind of processing necessary is different for each type. The composition of the date is important to the packer, for with the modern interest of the consumer in food values, he must know what components of the date he can mention on his labels and in his advertising.

Commercial date cultivation began in the United States at about the turn of the century. The pioneers expected that the dates would ripen as they did in the Algerian valley of Oued Rhir or in the Tunisian Djerid. They found, however, that the dates in the American Southwest did not ripen properly and that most of the crop was lost by insect and fungus damage, and by fermentation.

By this time a heavy investment had been made in the date industry and those engaged in it were unwilling to cut their losses. Instead, growers and packers, with the aid of research workers from the United States Department of Agriculture and the universities of Arizona and California began intensive studies in all branches of the date industry, but more particularly in the chemistry and physics of ripening, with the result that appropriate packing-house techniques were devised, so that the industry was saved from extinction. In the last 50 years, more research work on dates has been done in the Southwest of the United States than has been done anywhere else in the world in any period.

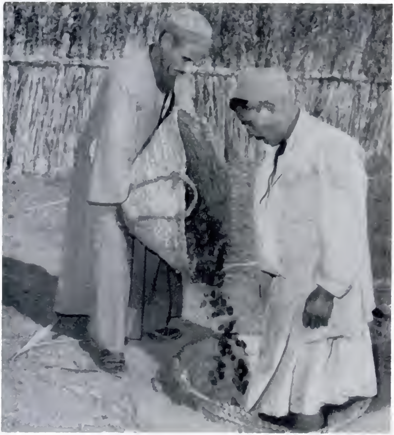
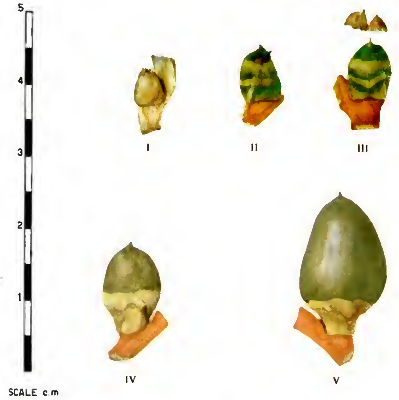


FIGURE 6. – Pressing dates barefoot.

The first comprehensive publication on the composition of dates was that of Vinson (1911), giving the results of six years' labor. This has been the foundation for much subsequent research on the subject. Rygg in 1946 summarized his own 15 years' work and added considerably to Vinson's information. The papers of Sievers and Barger (1930), of Haas and Bliss (1935), and of Cook and Furr (1953) are also of great value. These sources have been freely drawn upon in the following pages (see also " List of References ").

FIGURE 7. – Stages in the ripening of a date of the Beiyuudhi variety, Tripoli, Libya, April-October 1958.

(Courtesy Mrs. Joy Dowson)



	(I)	(II)	(III)	(IV)	(V)
Day and month of picking	14/4	15/5		29/5	12/6
Age from pollination . . .	4 days	5 weeks		7 weeks	9 weeks
Iraqi name	*Hababauk*	*Hababauk*		*Kimri* *Chimri*	*Kimri* *Chimri*
Libyan (coastal) name . .				*Ghamag*	*Ghamag*

NOTE: The date female flower has three carpels (I); only one is fertilized, the other two wither (II) and the exposed carpel tops fall off (III). Tops of carpels shown above fruit in (III).

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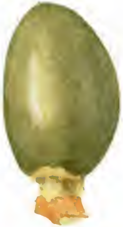
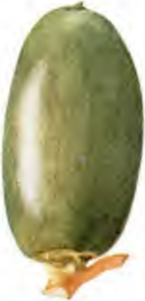


VI



VII

	(VI)	(VII)
Date and month of picking . . .	26/6	10/7
Age from pollination	11 weeks	13 weeks
Iraqi name	*Kimri* *Chlmri*	*Kimri* *Chimri*
Libyan (coastal) name	*Ghamag*	*Ghamag*

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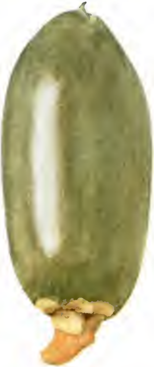
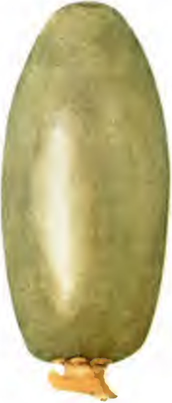


VIII



IX

	(VIII)	(IX)
Day and month of picking . . .	24/7	7/8
Age from pollination	15 weeks	17 weeks
Iraqi name	*Kimri* *Chimri*	*Kimri* *Chimri*
Libyan (coastal) name	*Ghamag*	*Ghamag*

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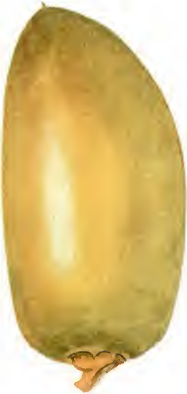

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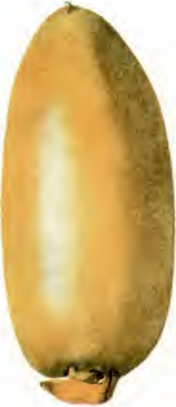

XI

	(X)	(XI)
Day and month of picking	21/8	4/9
Age from pollination	19 weeks	21 weeks
Iraqi name	*Khalaal*	*Khalaal*
Libyan (coastal) name	*Bisir* *Balah*	*Bisir* *Balah*

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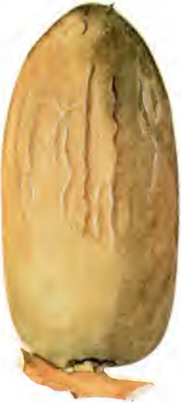

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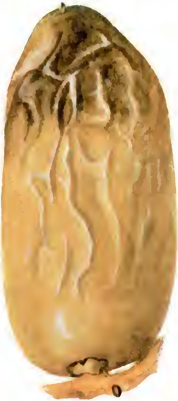

XIII

	(XII)	(XIII)
Day and month of picking	18/9	2/10
Age from pollination	23 weeks	25 weeks
Iraqi name	End of *Khalaal*	Beginning of *Rutab*
		Beginning of *Rutab*
Libyan (coastal) name	End of *Bisir* End of *Balah*	

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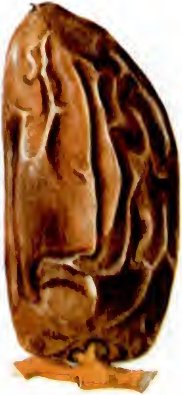
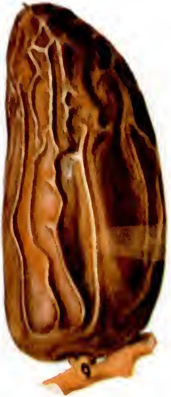


XIV



XV

	(XIV)	(XV)
Day and month of picking	16/10	30/10
Age from pollination	27 weeks	29 weeks
Iraqi name	*Rutab*	*Tamar*
Libyan (coastal) name	*Rutab*	*Tamar* *Ariish* (Eastern end of coast)

Date composition in each stage of ripening

MAIN CONSTITUENTS

Broadly speaking, the flesh of the fully ripe (*tamar*) date consists of two thirds sugar, a quarter water, and the rest cellulose, pectins, ash, etc. In the immature date the proportion of water to dry matter is high. The proportion falls as the amount of dry matter increases in the middle stage of development and again in the last stage, when the dry matter remains constant but water is lost by evaporation from the surface of the date.

TABLE 1. – Main changes in the composition of the Californian Daglat Nuur during development

Day of sampling	Stage of ripening	Fresh weight of fruit in grams	Percentage				Active acidity pH [1]
			of fresh weight	of dry weight			
			water	reducing sugars	sucrose	total sugars	
17.5.38	*Kimri*	0.2	78	5	8	13	5.5
14.6	"	2.6	83	25	4	29	5.1
12.7	"	9.8	85	34	6	40	5.3
16.8	*Khalaal*	15.1	79	20	40	60	5.7
13.9	50 % *Rutab*	14.4	41	13	61	74	6
27.9	90 % "	13.6	35	20	58	78	6
11.10	Tree-ripe (i.e., fully *Rutab*)	12.6	30	24	53	77	6.2

[1] For pH, see appendix 1.

(Adapted from Rygg, 1946)

Stages in ripening

The Arabic terms *kimri*, *khalaal* and *rutab* (Figures 7, 8 and 9) have been employed in the above table. It is necessary to explain them, and others to be mentioned later, because they are used in the literature of the date to denote stages in ripening for which there are no equivalent English words. The Iraqi nomenclature has been preferred to that of any other date-producing country because it has already been adopted in the United States.

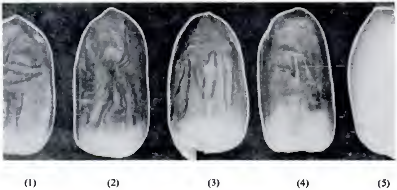


Figure 8. – Stages in the development of the *abul khusheim* condition in the Hallaawi date. From left to right: (1) *khalaal;* (2) soft *rutab;* (3) *rutab* drying; (4) elastic *tamar;* and (5) hard *tamar*. Basra, Iraq, 10 August 1932.

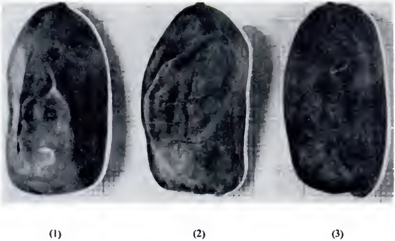


Figure 9. – Normal development of Hallaawi. From left to right: (1) no white shoulder, *rutab;* (2) soft elastic *tamar*; and (3) firm elastic *tamar*. Kutas-Saiyid, 10 August 1932. Basra, Iraq.

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The small, spherical and cream-colored female date which flowers immediately before pollination, and the small, immature fruit for a short while after pollination, is called in Iraq *hababauk*.

" KIMRI "

When the date has grown a little and become a clear, apple green, it is called in Iraq *chimri*. The local pronunciation of " k " as " ch " being vulgar, is frowned upon by educated persons, who write the word *kimri*. As this word is spelled so in the date lands of California, this spelling will be used here. It is, however, possible that the word *chimri* is not of Arabic origin but from the Persian or Kurdish. In that case the " ch " might be the correct digraph. That *kimri* are called *jimri* in Bahrein would seem to support that possibility.

In this book, by a " green " date is meant one that is of a green color. This statement of the obvious is made to avoid confusion, for, in American trade, and even in scientific journals, by " green " dates are sometimes meant immature dates, whether they are green, yellow or pink.

As Rygg was the first to discover, the development of the date in the green or *kimri* stage takes place in two phases, as follows:

The first, characterized by rapid increase in weight and volume, rapid accumulation of reducing sugars, low but increasing rate of accumulation of total sugars and total solids, highest active acidity, high moisture content though slightly less than that of the next phase.

The second, characterized by reduced rate of gain in weight and volume, greatly reduced rate of accumulation of reducing sugars, considerable reduction in the already low rate of accumulation of total sugars, slightly reduced active acidity and high moisture content.

" KHALAAL "

The change to the next stage, known as *khalaal*, is marked by the turning of the color of the skin from green to yellow, to chrome, or to yellow finely spotted with red, generally more on one side than on the other, to pink, or to scarlet. In this stage there are a continued decrease in rate of gain in weight (late in the stage there may even be a decrease in weight), a low rate of gain in reducing sugars, a rapidly increasing rate of gain in sucrose, total sugars, and of total solids, a continued decrease in active acidity and a decreasing moisture content.

It is to be noted that both the sucrose type and the reducing sugar type of date accumulate most of their sugar as sucrose during the *khalaal* stage. A comparison of Table 1 with the analyses of the Bahri date at different stages of development (Table 2, also adapted from Rygg) illustrates this phenomenon. This table shows also the remarkably rapid inversion of the sucrose during the next, or *rutab*, stage in the invert sugar date.

TABLE 2. – Main changes in the composition of the Californian Barhi during development

Day of sampling	Stage of ripening	Fresh weight of fruit in grams	Percentage			
			of fresh weight	of dry weight		
			water	reducing sugars	sucrose	total sugars
23.5.39	*Kimri*	0.5	81	17	5	22
21.6	"	5	86	43	5	48
2.8	"	14	85	45	14	59
2.9	*Khalaal*	16	64	17	62	79
11.9	Tree-ripe (*Rutab*)	14	39	79	0.25	79

(Adapted from Rygg, 1946)

" RUTAB "

The next stage (that is, the fourth, counting Rygg's two phases of the *kimri* as two stages) is the *rutab* (meaning wet), characterized by the date becoming more or less translucent, by the darkening of the skin from yellow, chrome or scarlet to brown or to nearly black, or, in the green group, for example, in the varieties Khadhar, Khadhraawi, Khadhrai and Khadhuuri (all these names mean green) to green, and by the softening of the date. In the literature, the beginning of softening is frequently called the beginning of ripening and the date is said to be ripe when the whole of it has become soft. As mentioned before, however, ripe is an elastic term, meaning dates in the *khalaal* stage to one class of customers and those in the *tamar* stage to another.

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It has already been observed in respect of the reducing sugar date, Barhi, that all the sucrose accumulated during the previous, *khalaal* stage, inverts.

Table 3, adapted from Turrel, Sinclair and Smith (1940) shows some of the changes that take place in the date (in this instance the Daglat Nuur) as it softens from the apex to the base.

TABLE 3. – Some changes taking place in the Daglat Nuur as it softens from the apex to the base

Constituent	Percentage of flesh (wet weight)		
	Base	Middle	Apex
Water	49.70	37.92	31.64
Dry matter	50.30	62.08	68.36
True tannins (cinchonine precipitate)	0.98	0.74	Slight +
Tannins and tannin-like substances (stiasny compounds)	1.77	1.84	0.87

(Adapted from Turrell, Sinclair and Smith, 1940)

With softening, the last of the tannin under the skin is precipitated in an insoluble form, so that the date loses any astringency that may have remained in the *khalaal* stage from the *kimri* stage.

" TAMAR "

The final stage in the ripening of the date is called *tamar*. The date has lost much of its water, enough to make the sugar to water proportion sufficiently high to prevent fermentation. This stage is equivalent to that of the raisin in the grape, the dried prune in the prune type of plum. The texture of the flesh of dates of the soft type is somewhat soft at the beginning of the stage and gradually becomes firmer, though remaining pliable with time. The skin, in most varieties, adheres to the flesh and wrinkles as the flesh shrinks, but the skin of some varieties is brittle and cracks as the flesh recedes from it, leaving bare, sticky patches of flesh where sand and insects can enter. The color of the skin and of the underlying flesh darkens with time.

The changes that occur during storage will be considered later. It is enough to mention here that soft dates in the *tamar* stage will keep in excellent condition for a year at ordinary temperatures, if tightly pressed, and in fair condition, if loose.

The dry, or hard date, which usually does not pass through a proper *rutab* stage or which never softens at all in the *tamar* stage, although it does not differ much in water content from the soft date *tamar*, is of much harder texture.

ARRESTED DEVELOPMENT

In most varieties of dates, the softening starts at the apex and travels toward the base. In the Barhi and some other varieties, the softening of the tissues may start anywhere. In those varieties in which the apex is the first part to ripen, there is a difference between the composition of the soft apex and that of the still hard base, as has been mentioned previously. The former contains a lower proportion of water and of sucrose than the latter, but Rygg (1946) does not consider that the difference in appearance between the white shoulder (or base) and the apex is due to the difference in the sugar to moisture ratio, but thinks it may be connected with changes in the pectic substances.

Some varieties habitually dry up when they have reached this stage. They are usually characterized by a rounded, hard, shiny, buff-colored base and a pointed, shrivelled, dark-colored apex. Such are the Zahdi and Ashrasi of northern Iraq, where dates in this condition are known as *chasib*, or *gasib*, from *gasb*, meaning dry. These varieties in California, however, make a softer date. Also in varieties that normally develop through the *rutab* stage to the complete *tamar*, the phenomenon of arrested development may appear, especially in seasons when a hot, dry wind blows instead of a hot, damp one. The Hallaawi of Basra is well known for this peculiarity. Its dates in this condition are known as *abul khusheim*, " the father of the little nose, " in allusion to the light-colored, rounded, hard shoulder of the date. These are the " putty ends " of the New York repackers. The age of the palm also affects the dryness of the fruit. The dates of very young palms, and of very old ones, are drier or more putty-ended than those in the prime of life.

Dates which normally would be classed as of the reducing sugar type when in this hard state also resemble the dates of the ordinary, dry varieties in having a part of their sugar as sucrose. Some analyses made by Cavell (1947) of Basra dates gave the results shown in Table 4.

TABLE 4. – Differences between the composition of normal dates and those which have dry bases

Variety	State	Percentage of dry weight		
		Total sugars	Reducing sugars	Sucrose
Hallaawi	Fresh	84.3 – 88	81.4 – 88	0 – 2.9
”	” (dry bases)	85.8	73.2	12
Zahdi	Fresh	82.9 – 86.2	73.9 – 75.3	7.6 – 12.3
”	” (dry bases)	85.4	52.4	31.5

(Cavell, 1947)

On the coast of Libya the heat is not sufficient to ripen the dates properly, and the *khalaal* left hanging on the palm suffer from insect attack, or from rotting, or may fall to the ground. However, some shrivel and darken at the apex, and dry down to a leathery-textured date know locally as *ariish*, which is much the same, though not of such a good quality as the *chasib* of northern Iraq. The original meaning of *ariish* is an arbor or a support for a vine. Perhaps this meaning has been extended to dates left hanging on the bunch after most have been removed, from a fancied resemblance to grapes hanging from a pergola.

The date palm as potential sugar (syrup) producer

Sugar cane and sugar beet contain chiefly one type of sugar, namely, sucrose, known in the form of a white, crystalline product.

Dates contain chiefly a mixture of sugars, known in the form of syrup. Although these sugars differ in a number of properties, as will be seen in the next paragraph, from the point of view of their nutritional value they are equally valuable as a source of energy. While both cane and beet sugar are produced commercially on a large scale, commercial date syrup manufacture is in the development stage, although syrup has been made in the home since ancient times. It is, however, interesting to note that well-watered, manured and well-cared-for date palms, planted at 125 to the hectare, will produce 100 kilograms of dates a year each, with a total sugar content of over 60 percent. The yield of total sugars would thus be over 75 quintals per hectare. However, the average yield over the whole date-growing world must be much lower, perhaps only a fifth of this, i. e., 15 quintals. Table 5 shows figures for cane and beet sugar.

TABLE 5. – Production figures for cane and beet sugar in quintals per hectare

Cane sugar	Quintals per hectare
India	30
Cuba	40
Philippines	40
Réunion	70
Java (Indonesia), prewar	165
Hawaii	250
World average	70
Beet sugar	
Average for Europe	50

The date palm is also a possible source for the production of gur (palm sap). For comparable figures, see appendix 2.

Sugars in dates

Reference has been made in the previous pages to the sugars present in the date, and some brief explanation is desirable at this point, in simple terms, of certain elementary facts of sugar chemistry, and the meaning of the terms sucrose, invert sugar, reducing sugars, glucose, dextrose, fructose and levulose.

Sugar, also called sucrose and saccharose, is a white, crystalline, water-soluble substance, found in great abundance in the vegetable kingdom and especially in the sugar cane and sugar beet, the sources of commercially produced sugar. In chemistry it is classified as a carbohydrate, i. e., it is one of the group of compounds made of only three kinds of atoms: carbon, hydrogen and oxygen, which are formed by all green plants under the influence of light, a reaction called photosynthesis. In this reaction, carbon dioxide of the air combines with water of the plant to form carbohydrates. Analysis of sugar reveals also that the hydrogen-oxygen ratio is the same as in water. Because of this, sugar (like starch and cellulose) was once regarded as a hydrate of carbon. The name carbohydrate has continued to be used, even though the concept of the chemical nature of the substances so classified has changed completely.

The chemical formula for sugar, written in its simplest form, is $C_{12}H_{22}O_{11}$, meaning that one molecule of sugar consists of 12 atoms of carbon (C), 22 of hydrogen (H) and 11 of oxygen (O). The chemical composition and properties of sugar (sucrose) are the same, whether it is obtained from sugar cane or from sugar beet; so are its physical characteristics, such as solubility in water, melting point, sweetness.

INVERT SUGAR, GLUCOSE AND FRUCTOSE

Sugar (sucrose) also exists naturally in a wide variety of fruits in a special form, known as invert sugar. This sugar is a mixture in equal molecular proportions of glucose (dextrose) and fructose (levulose). The equimolecular mixture can be obtained artificially by heating a solution of sucrose in water with a little hydrochloric or other acid. The reaction which takes place, known as hydrolysis, can be expressed in chemical formulas (in simplified form) thus:

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$

or: sucrose plus water equals glucose plus fructose.

These twin forms of sugar, glucose and fructose, though identical in that both consist of the same number of carbon, hydrogen and oxygen atoms, nevertheless differ in their chemical and physical characteristics, such as manner of crystallization, sweetness, solubility in water, melting point. They have a further difference which can be observed and measured by means of a polarimeter. With this instrument polarized light is passed through a sugar solution. The sugar molecules cause the plane of polarization to rotate to the left or right, and when measured under known conditions, the amount and direction of the rotation is characteristic for each sugar, and are thus a means of identification.

Sucrose has the effect of rotating the plane of polarization to the right and is therefore called dextrorotatory. The glucose (dextrose) formed during hydrolysis has the same property. The fructose formed at the same time has, however, the contrary property of rotating the plane of polarization to the left, and is therefore known as levorotary. For this reason, fructose is also known as levulose.

Because the optical rotation to the left of the fructose solution is stronger than the rotation to the right of the glucose, the equimolecular mixture of the two resulting from the hydrolysis of sucrose also results in a rotation to the left. Or, in other terms, the optical rotation changes from a positive to a negative value. Consequently, the term inversion is applied to the hydrolyzation process, and the resulting mixture of glucose and fructose is called invert sugar.

The process of inversion brought about by the use of an acid can also be achieved with invertase (also called sucrase), an enzyme found in many plants and in animal intestines. Honey is largely invert sugar, since bees produce invertase.

REDUCING AND NONREDUCING SUGAR

Invert sugar and its constituents, glucose and fructose, differ from sucrose in that the first three are classified as reducing sugars, while the last is a nonreducing sugar.

For present purposes, it is sufficient to note that this classification is based on the behavior of the sugar when dissolved in water and mixed with certain substances, i. e., Fehling's copper tartrate reagent or phenylhydrazine. Sucrose is not reduced, e. g., changed chemically, by these substances, and is therefore considered a nonreducing sugar. On the other hand, glucose and fructose and their mixture, invert sugar, all react chemically with the test solutions. They are therefore known as reducing sugars.

Some of the differences between glucose and fructose and between both and sucrose are shown in Table 6. It will be seen that there is a striking difference in sweetness. If sucrose (cane or beet sugar) has sweetness 1, glucose is only about half as sweet; fructose, however, is slightly sweeter than sucrose.

Consequently, invert sugar, consisting of both glucose and fructose, is somewhat less sweet than sucrose. For comparison, the table also shows the degree of sweetness of saccharine, though this is not a sugar nor a carbohydrate.

It is to be noted that the inversion of the sucrose is not peculiar to the reducing sugar type of date; it occurs, though to a lesser degree, in the sucrose dates also. Thus, though in the *khalaal* in both types of dates a fifth or rather less of the sugar is of the reducing type, yet even in the sucrose type, as much as from a third to a half of the total sugar

TABLE 6. – Sugars and saccharine – Comparison of characteristics

Name of sugar	Formula	Relative sweetness	Solubility in 100 cu. cm. of water	Melting point (°C.)	Additional characteristics
SUCROSE (nonreducing sugar) Saccharose Cane sugar Beet sugar	$C_{12}H_{22}O_{11}$	1	179 gm. at 0°C. 219.5 gm. at 30°C. 487.2 gm. at 100°C.	186	Crystallizes in monoclinic crystals, which to the naked eye appear as tiny cubes
GLUCOSE (reducing sugar) Dextrose, grape sugar Blood sugar	$C_6H_{12}O_6$	0.5-0.6	120.5 gm. at 30°C. (as hydrate $C_6H_{12}O_6 . H_2O$)	146	Crystallizes in tiny needles
FRUCTOSE (reducing sugar) Levulose Fruit sugar	$C_6H_{12}O_6$	1.0-1.5	441.7 gm. at 30°C.	102	Very hygroscopic (water-absorbing) Easily affected by heat and alkali Can stand a maximum of 70°C. without decomposition
INVERT SUGAR (reducing sugars, an equimolecular mixture of glucose and fructose)	—	0.8-0.9	230 gm. at 30°C.	—	—
SACCHARINE	—	200-700	—	—	—

has inverted by the completion of softening, that is, when the date is fully *rutab*. Inversion continues during storing and at a rate depending on the temperature and humidity of the surrounding air. At low temperatures inversion is a slow process.

The packer needs to keep his processing temperatures low when maturing the sucrose date, Daglat Nuur, so as not to promote the inversion of the sucrose, thereby causing the date to become syrupy. He is not so limited in processing the invert date. The nature and role of the enzyme *invertase*, responsible for the inversion of sucrose in dates, was studied by Vinson (1911).

TYPE OF SUGAR AND THE PACKER

Before considering the next stage in the ripening of the date, the reasons why the kind of sugar of which the date is chiefly composed concern the packer may be given. It would be a simplification, perhaps unwarranted by the chemical evidence, to attribute the hardness and dryness of dry dates to the presence of sucrose. It is clear, however, that the persistence of sucrose in the date after the end of the *khalaal* stage is closely related to the phenomenon of the hardening of the date after passing through a proper *rutab* stage, as in the Daglat Nuur, or omitting the *rutab*, or almost omitting it, in most dry dates.

The dry date has a ready market in the desert, for it keeps well, is a highly concentrated food, and is convenient to carry in the pocket or saddle bag. In the market which the modern packer supplies, there is no demand for such dates, and he is, therefore, forced to hydrate them in order to make them softer and saleable.

The reason why a date with a certain ratio of sucrose plus reducing sugars to water should be firmer and drier than a date with a similar ratio but with all the sugar inverted is not clear. Sucrose certainly melts at a higher temperature (186 °C.) than either glucose (146 °C.) or fructose (102 °C.), but all these temperatures are much higher than are ordinarily employed in processing. All the sugars, moreover, are normally in solution in the dates.

Cook and Furr (1953) give the sugar analyses of the dates in stored condition of 51 imported varieties now growing in the United States. The analyses of 21 of the better known of these are given in Table 7. It will be noted that, generally speaking, soft dates are of the invert sugar type and dry dates of the sucrose type. It will also be observed that there is little difference in total sugar among the three types.

Cook and Furr's comprehensive statement is further summarized in Table 8.

From the above, it may readily be seen that about three quarters of the dry matter of the flesh of dates in their cured, stable condition is sugar, irrespective of variety, and that soft dates, and these are the commonest, contain little sucrose, while the sugar of the dry dates is about one third sucrose and two thirds reducing sugars (invert sugar). The semi-dry dates occupy a position between the other two groups in respect of their sugar balance.

TABLE 7. – Analysis of the sugars in stored samples of some well-known imported varieties of dates grown in the United States

Variety	Country of origin	Percentage dry weight		
		Total sugars	Reducing sugars	Sucrose
SOFT				
Barhi	Iraq	85	85	0
Gantaar	"	83	83	0
Ghars	Algeria	77	77	0
Haiyaani	United Arab Republic	79	76	3
Hallaawi	Iraq	82	82	0
Istaamraan (Sayir)	"	74	74	0
Khadhraawi	" (Baghdad)	80	80	0
"	" (Basra)	82	82	0
Khastaawi	"	81	81	0
Khulaas	Hasa (Saudi Arabia)	79	79	0
Majhuul	Morocco	77	77	0
Maktuum	Iraq	77	77	0
Saiidi	United Arab Republic	80	77	3
Samaani	United Arab Republic	81	81	0
SEMIDRY				
Ashrasi	Iraq	71	65	6
Dayri	"	75	70	5
Daglat Nuur	Algeria	77	39	38
Zahdi	Iraq	78	71	7
DRY				
Daglat Beidha	Algeria	76	17	59
Kinta	Tunisia	80	35	45
Thuuri	Algeria	73	41	32

(Adapted from Cook and Furr, 1953)

The outstanding exception to the conclusion drawn in the last sentence is that of the Daglat Nuur, which is the sucrose date *par excellence*, and which in the table is included in the semidry class. It is true that the world-wide reputation of this magnificent date has been built up on its appearance and taste in its soft stages, but in a dry year most of the dates left to dry completely on the palm will develop into the *frezza* or mummified dates, which are nearly as hard and dry as bullets. It is not suggested that the classification of Cook and Furr's table (devised by Nixon in 1950) of the 51 varieties into soft, semidry and dry is wrong in respect of the Daglat Nuur. Attention is only drawn to the anomalous character of this date, which has a high sucrose content, which will de-

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TABLE 8. – Summary of Cook and Furr's statement

Constituent		Percentage dry weight		
	Type of date	Soft	Semidry	Dry
	Number of varieties analyzed	34	9	8
Total sugars	Average	78	77	77
	Maximum	85	82	82
	Minimum	67	71	73
Reducing sugars	Average	78	60	41
	Maximum	85	81	76
	Minimum	61	45	17
Sucrose	Average	1	17	36
	Maximum	20	38	59
	Minimum	0	0.1	1

velop into a typical dry date if left long enough on the palm, but which, unlike the true dry dates, under suitable conditions passes through an excellent soft stage.

The experimental agricultural station at El-Arfiane, Sahara, analyzed samples of very mature (*tamar*) Daglat Nuur dates, as listed in Table 9.

One more series of analyses of the Californian Daglat Nuur during its development, an adaptation from information presented by Postlethwaite (1930), is given in Table 10, because it is clear and concise.

TABLE 9. – Sugar contents, in percentages, of very mature (*tamar*) Daglat Nuur dates

	Sucrose	Reducing sugars	Total sugars
	33.32	57.68	91.00
	30.25	58.75	89.00
	37.50	45.50	83.00
	34.75	27.75	62.50
	34.75	43.25	78.00
	32.50	45.50	78.00
	48.00	35.00	83.00
Average	35.86	44.77	80.68

(Provided by Girard, 1960)

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TABLE 10. – Analysis of the Californian Daglat Nuur

Stage	Condition of date	Percentage wet weight			
		Sucrose	Reducing sugars	Total sugars	Water
Kimri	Green, just turning to yellow	3	3	6	80
Khalaal	Yellow, just turning to pink	23	7	30	50
"	Pink, just turning to dark yellow	35	12	47	36
Rutab	Fully dark yellow	42	13	55	31
"	Darker yellow or amber	. .	. .	58–60	28–30

(Adapted from Postlethwaite, 1930)

Postlethwaite added that dates in the last of the above groups were perishable fruit and advocated drying them down to 25 percent water before marketing.

Copertini (1937) gives the analysis of six samples of Saiidi *tamar* dates from the previous season's crop in Cyrenaica (Libya). From these, the following maxima and minima have been extracted in Table 11.

TABLE 11. – Analysis of Saiidi (*tamar*) dates in Cyrenaica (Libya)

Constituent	Percentage wet weight	
	Maximum	Minimum
Water	20.71	12.38
Dry matter	84.12	76.09
Protein (N × 6.25)	1.90	1.25
Ether extract	0.45	0.30
Reducing sugars	71.18	62.60
Sucrose	0.86	0.30
Total sugars	72.04	62.98
Other soluble non-nitrogenous matter	17.13	7.34
Cellulose	1.83	1.67
Ash	1.77	1.50
Acidity (in cubic centimeters of normal alkali)	4.00	3.40

(Adapted from Copertini, 1937)

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The following analysis (Table 12) of the Bikraari dates of northern Tripolitania (Libya), was made by the Central Technical Institute, TNO, the Netherlands, in 1957. The samples were from the ordinary, poor-quality, sun-dried, *khalaal* halves, dried in the sun, and stamped into baskets, and were six months old at the time of analysis.

TABLE 12. – Analysis of the Bikraari sun-dried dates from northern Tripolitania (Libya

Constituent	Percentage wet weight
Reducing sugars	63.5
Soluble nonsugars	5.0
Water	22.5
Fiber	9.0
Total	100.0

(From Central Technical Institute, TNO, the Netherlands, 1957)

Cleveland and Fellers (1932) give the analysis of the Hallaawi date from Iraq, as it is received in the United States for repacking (Table 13).

TABLE 13. – Analysis of the Hallaawi date from Iraq

Constituent	Percentage wet weight
Water	19.0
Ash	2.2
Protein (N × 6.25)	1.7
Fat (ether extract)	1.9
(Reducing sugars as invert)	(73.5)
Total carbohydrates other than crude fiber	73.7
Crude fiber	2.2
Sucrose	0.0
Total	100.7

(From Cleveland and Fellers, 1932)

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To conclude the information on the composition of dates throughout maturation, reference is made to work that has been carried out by Ashmawi, Aref, and Aziz Hussein (1956) on the Zaghluul (Zagloul) date, representing the red type of fresh date. Tables 14 and 15 show their analyses, which were compiled weekly.

They analyzed total solids, among them being the reducing, and nonreducing sugars, and they classified the maturation period into stages, namely, green, turning, fully colored and discolored. The *tamar* stage does not exist in this variety. As the tables show, throughout maturation total solids and total sugar content increased. Total sugar content, however, increased only up to the " fully colored " (edible) stage, but decreased in the discolored or *rutab* stage.

If the sugar content is used as an index of ripeness, the fully colored stage should be considered as the ripe stage and, consequently, the discolored (*rutab*) would be an overripe stage. In the *rutab* stage, the total sugar content decreases from 84 to 59 percent (Table 14), the fruit loses its characteristic color, and the skin becomes wrinkled and loose. Such dates must have undergone fermentation during the softening process. At the end of this stage, which lasts only one or two days, the flavor is insipid and the fruit spoils rapidly by souring or molding. Therefore, the fruit is usually consumed in the fully colored stage.

Enough general analyses have been given to show the similarity between cured dates of different varieties grown in widely separated places, if allowance is made for the existence of the two types of date, the sucrose and the invert sugar date.

Summary of names for stages in ripening of the date

The table on p. 292-293 permits easy comparison of the names used for the same ripening stages in different countries. It summarizes what has already been mentioned and includes some additional information.

Constituents

SUGAR AND WATER

The two major constituents of the date, and those that most concern the packer are sugar and water. The packer would probably consider water the most important, because the total sugar content is fixed by the time

TABLE 14. – Main changes in the composition of Zaghluul dates (United Arab Republic) at different stages of growth

Day of sampling		Stage of ripening	Percentage dry matter	Percentage dry weight		
				Total sugars	Reducing sugars	Sucrose
25	June	Green (*kimri*)	14.82	42.67	41.66	1.01
2	July	"	15.17	46.55	42.92	3.63
8	"	"	15.25	47.31	43.25	4.06
15	"	"	15.35	49.10	44.52	4.58
22	"	"	15.47	50.82	44.94	5.88
29	"	Turning (*khalaal*)	15.57	52.70	45.34	7.36
5	August	"	15.69	56.01	45.44	10.57
12	"	"	15.88	63.99	51.31	12.68
19	"	"	16.06	65.81	53.00	12.81
27	"	"	16.71	67.06	53.78	13.28
3	September	"	17.83	68.72	54.82	13.90
10	"	"	21.17	77.79	58.03	19.76
17	"	"	28.47	81.06	59.74	21.32
24	"	(Full color)	35.67	80.84	42.38	38.46
30	"	"	38.32	84.26	35.79	48.47
7	October	Discolored (*rutab*)	39.46	86.90	43.32	43.58
9	"	50 % soft	40.04	64.46	52.07	12.39
12	"	75 " "	41.13	61.19	54.41	6.78
15	"	100 " "	44.57	59.33	53.28	6.05

(Adapted from Ashmawi, Aref, and Aziz Hussein, 1956)

TABLE 15. – Analysis of Zaghluul dates (United Arab Republic) at the edible stage

Stage	*p*H	Total soluble solids by refractometer	Tannins (fresh weight basis)	Tannins (dry weight basis)
		.... Percentage	....	....
Full color (*khalaal*)	6.00	32.50	0.13	0.33
Discolored (*rutab*)	6.10	32.50	0.12	0.30
50 % soft "	6.15	32.00	0.11	0.27
75 " " "	6.20	32.00	0.10	0.24
100 " " "	6.40	31.80	0.09	0.20

(Adapted from Ashmawi, Aref, and Aziz Hussein, 1956)

TABLE 16. – Water content of some Algerian dates

Variety		Stage	Percentage water	
			(Husson)	(Girard)
Soft dates	Ghars	*Tamar*	15	16–18
Semidry dates	Dagal Bu Alas	"	15	
Dry dates	Dagal Kentiishi	"	18	
	Mesh Dagla	"	16	
	Dagal Hurra	"	13	
	Daglat Beidha	"	11	8–12
Daglat Nuur		*Khalaal*	31	
		Bisir (red)		61
		Balah (chrome)		50
		½ *Balah* (*khalaal*)		45
		½ *Murattab* (*rutab*)		40
		Murattab (*rutab*)		35–40
		Tamar		25–28
		Frezza		16–24
		Tamar 1st quality	25	
		" 2nd "	23	
		" 3rd "	13	
		Frezza (exportable)	15	
		" (not exportable)	12	
		Hashaf (not for commerce)	10	

NOTES: (1) Analyses made by Bonas at the Institut agricole d'Algérie (Girard). (2) *Frezza:* mummified. (3) *Hashaf:* shrivelled dates which have started to shrivel before the *frezza* and which have carried the shrivelling further. Used for cattle food. (From Husson [1931] and Girard [1960].)

he has to deal with the dates. The water content, on the other hand, can be altered at will either by dehydration or hydration (the adding of water).

The amount of water in the dates arriving at the packing house varies considerably. In the United States, where the Daglat Nuur is the chief date, where care is taken to prevent mold, fermentation and souring, and where the climate permits the grower to harvest his crops as soon as possible, dates may arrive at the packing house with a moisture content of as much as 50 percent.

At the other extreme, the repacker and processer in New York may receive dates in bulk from Iraq with a moisture content of no more than 15 percent.

In Algeria and Tunisia the Daglat Nuur is delivered to the packing houses when it contains about 25 percent of water. Export is only permitted when the total sugar content is twice that of the water.

The packer wishes to sell his dates in as soft a state as possible in order to reduce his expenses on drying, caused not only by the loss in weight of the dates but also by the time, fuel and space necessary for drying. In order to give his customers dates in the juicy condition they prefer, he must, however, not allow the moisture content of the dates that leave the packing house to be above the point at which microbial activity may start. It is recommended that the equilibrium moisture content curve be used, which shows the relation between the moisture in the air and in the date (see appendix 4).

Some analysis (water content) of North African dates, as given by Husson (1931) and Girard (1960, private communication), are shown in Table 16.

REMAINING CONSTITUENTS

The remaining constituents of the date need not be considered here in detail because, although some of them are important in a diet, their presence or absence for the most part does not influence the packer in the treatment which he gives his dates.

CELLULOSE, STARCH, ETC.

The walls of the cells of which the date is made up are composed chiefly of cellulose. Cellulose and other nonsoluble solids comprise about 85 percent of the dry matter in the very small, green date, but as the proportion of sugar increases, that of cellulose decreases. The seed of the date is largely formed of hemicellulose, which is readily converted into dextrose on heating with an acid. In the embryo there is an enzyme, cytase, which effects the same transformation when the seed germinates.

Vinson's analyses (1911) of 32 samples of several varieties of dates in various stages of development give *marc* (solid residue), which he defines as all insoluble matter, and whose chief constituent must be cellulose, as varying from 4.09 percent to 11.97 percent, with an average of about 7 percent (wet weight), or 4.09 percent to 6.28 percent, with an average of about 5 percent (dry weight).

Analytical data from fully ripe Zahdi dates showed crude fiber content varying from 4.5 to 10.1 percent, depending on the area from which the dates came (information from Kapsiotis; analysis from Daubney, Iraq, 1956).

A fully-cured, soft date does not contain more than about 2 percent of crude fiber or cellulose (Cleveland, 1932; Copertini, 1937).

According to Rygg (1946), it is not likely that cellulose is converted into sugar in a ripening (softening) date (*rutab* stage). The last part to soften is that round the seed at the basal end of the date, and it is that part which is known as the rag. The amount of rag present in the Daglat Nuur date is a good indicator of the degree of maturation it has reached. Sievers and Barger (1930) stated that there are grounds for believing that the characteristic flavor of the Daglat Nuur is largely concentrated in the rag.

Starch is a food reserve carbohydrate found in plants. Lloyd (1910) observed starch in dates only at about the time of pollination and not later. Ashmawi *et al.* (1957), however, ascertained starch in the Samaani date of the United Arab Republic from the *kimri* stage, 12.79 percent (dry weight), right to the completion of the *rutab* stage, 3.10 percent (dry weight).

TANNIN

Nearly all dates are astringent in the *kimri* stage, owing to a layer of tannin a little below the skin of the date. That the tannin is not in the skin or immediately below it was demonstrated, as Vinson reports, in 1906 at the Tempe orchard in Arizona, where migratory rats nibbled away the outer covering of the fruit down to the principal tannin zone, but not through it.

As Turrell *et al.* (1940) have shown, the presence of the tannin layer preserves the *khalaal* from the attack of *Alternaria* sp., the fungus causing side-spot decay in the *rutab* date.

There are a few varieties of date which are not astringent when green. Such are the Shiraani of Basra, the Dueiki of the United Arab Republic, the Taaliis of the Fezzan, the Areshti of Algeria, and the Arsebabo of Tibesti (Chad).

When the dates lose their green color and become yellow or red, the tannin is deposited in the giant cells, in which it has been present in a soluble state, as insoluble grains, and the astringency disappears. The speed of the process varies with the variety, so that those varieties which quickly lose their astringency, for example, the Limsi of North Africa and the Hallaawi and Barhi of Basra, are those which are first found as *khalaal* for sale on the market.

Tannins and tannin-like compounds were found by Turrell *et al.* (1940)

to amount to 6 percent (wet weight) of Californian Daglat Nuur *kimri*. The percentage dropped to 1 percent in the *rutab*. Lloyd (1910) considered tannin to be a nutrient.

PECTIN

Pectic substances, that is, protopectin, soluble pectin, etc., are important to the date syrup manufacturer, because their presence makes the filtration of the date slurry difficult, so that pretreatment of the slurry (boiling, *p*H adjustment), and the addition of a filter aid are advisable. The enzyme, pectase, more exactly known as pectin esterase, will cause the pectin to gel. Date juice will also gel on long boiling. Vinson (1911) states that such a jelly, known as *colache*, is prepared by the Mexicans.

Rygg (1946) found that soluble pectins declined from about 2 percent (dry weight) in *kimri* to about half that percentage in the *rutab*, that protopectin declined from about 4.5 percent to about 1 percent, and total pectic substances from about 6.5 percent to about 2 percent.

CONSTITUENTS OF PARTICULAR FOOD VALUE

The mineral constituents of dates have been studied by Cleveland (1932) and by Haas and Bliss (1935). The ash of dates amounts to about 2 percent of cured dates (wet weight). This ash contains potassium, chlorine, phosphorus, silicon, sulphur, and other elements. Nearly half of the ash is potassium, about 15 percent chlorine and about 8 percent phosphorus. Calcium amounts to about 5 percent of the ash and iron to about 0.25 percent (Cleveland), so that the date is only a small supplier of these necessary metals. Haas and Bliss (1935) place sodium fourth and phosphorus fifth.

Perrot and Lecoq (1935), in their analysis of the ash of the Algerian Daglat Nuur make no mention of the presence of potassium, which is commonly found in the storage tissue of plants, but show the mineral constituents as magnesium (0.08 percent), phosphorus (0.07 percent), sulphur (0.05 percent) and calcium (0.02 percent), all of wet weight of flesh. Probably they were interested only in the elements of particular importance as constituents of food. U.S.D.A. Agriculture Handbook No. 8, *Composition of foods* (1950), gives the following contents per 100 gram edible portion: calcium, 72 milligrams; phosphorus, 60 milligrams; and iron, 2.1 milligrams.

The vitamin content of foods is another matter of public interest, so that the packer needs to know what he can advertise about the vitamins in dates. Smith, in 1928, made some preliminary determinations on dates grown in Arizona, and this author and Meeker published (1931) the results of more extensive work. In the following year, Morgan investigated the vitamin content of some Californian and Iraqi dates. Booher *et al.* (1942) include the results of investigations in dates in their general compilation of vitamins in foods. From the latter, it appears that ripe Californian Daglat Nuur dates contain 66 international units of Vitamin A in 100 grams, fresh, tree-ripened Californian Hallaawi about the same, and Californian Saiidi about 350 units.

Smith and Meeker, working with Daglat Nuur, Maktuum and Thuuri dates, found them to contain about half as much Vitamin B_2 or G as Vitamin A and about a third as much Vitamin B_1 or F. They found no appreciable amounts of Vitamins C or D. Perrot and Lecoq (1933, 1935) found Algerian Daglat Nuur contained a moderately large quantity of Vitamin A, less of B, a very little of C and E, and no D. Agriculture Handbook No. 8, *Composition of foods* (1950) gives the following contents per pound, as purchased: Vitamin A, 220 international units, thiamine (B_1) 0.35 milligram; riboflavin (B_2) 0.38 milligram and niacin 8.6 milligrams. It may be concluded that dates are not an important source of vitamins. Nelson (1951), however, sums the matter up as follows: " Dates contain carotene and vitamins of the B complex, both in notable amounts, but no Vitamin C. "

The remaining constituent of the date of particular interest is protein, but only a small quantity is found in this fruit. It varies with the variety and more with the stage of maturity, but it is roughly 1.75 percent (1.7 to 2.95 percent, Balland, 1923) of the wet weight of the flesh.

FAT, ACID, PIGMENT, ESTERS

The flesh of the date contains little fat (0.06 percent to 0.72 percent, Balland [1923]; 0.31 percent – 1.9 percent, Cleveland and Fellers [1932]; 0.3 percent – 0.45 percent, Copertini [1937], all wet weight). These analyses presumably include the skin, and in the skin (dry weight) Hilgeman and Smith (1937) found from 2.52 percent to 7.42 percent of wax. These authors do not give the weights of the whole date and of its skin, so that the proportion of the weight of skin wax to the weight of the whole date cannot be calculated. However, the figures suggest that the wax on the surface of the skin is only a small part of the total fat of the date.

The date juice is generally slightly acid, but there is one record of dates with an alkaline juice (wet Barhi with a *p*H reading of 7.2) in Rygg *et al.* (1953). The greatest acid concentration in dates recorded in this publication and in Rygg's earlier one (1946) is that which gave a *p*H reading of 5.0 for selected dry Daglat Nuur (see appendix 1 for *p*H value).

Rygg *et al.* make no definite statement on the role of acidity in the date, but they go so far as to indicate that high acidity is often associated with poor quality. The degree of acidity in the date is proportional to the water content, and therefore inversely proportional, once the date has reached its maximum water content, to the degree of maturity reached. The nature of the acid or acids in dates has not been determined.

Rygg (1946) states that the yellow pigment in the Barhi date is a flavone, or a flavonol, and that the red pigment in the Daglat Nuur is an anthocyanin.

As has been mentioned, there has been research extending over several years for the purpose of isolating the body or bodies that give the date its flavor. This flavor might be a characteristic of an ester or of a group of esters, but up to the present there appear to be no published reports of the results of the work.

Osmotic pressure

As the ripening date loses moisture, the concentration of the cell sap naturally increases, and hence the osmotic pressure rises inside the cell. Turrell *et al.* (1940) measured the pressure in Californian Daglat Nuur and found that it rose from 14 atmospheres in the *kimri* in May to 86 atmospheres, or 84 kilograms per square centimeter, in the *rutab* in September.

Rygg *et al.* (1953) make the interesting suggestion that the greater susceptibility of the Daglat Nuur to spoilage compared with that of the Khadhraawi may be due to the sugar of the former being predominantly sucrose, while that of the latter is reducing. Osmotic pressure depends more on the number of molecules in a given volume of solution than on their size, and as the molecules of sugar in a given quantity of Khadhraawi date are much more numerous than those in the same quantity of a Daglat Nuur date, the osmotic pressure in the former is greater than in the latter, and consequently microorganisms in the Khadhraawi date have a less

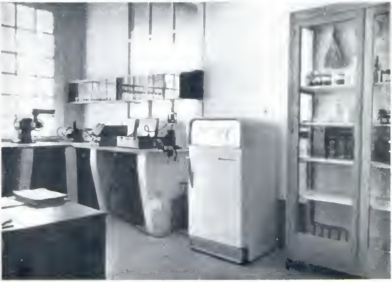

FIGURE 10. – View of laboratory at the Date-Processing Research Station, Tripoli, Libya. From left to right, on bench, are: mincing machine, pump of vacuum drying oven, vacuum drying oven, apparatus for quick determination of moisture, date pit grinder, refrigerator, and demonstration cupboard.

suitable medium on which to grow. It may make this paragraph clearer if it is recalled that during the inversion of sucrose, each molecule of that sugar is converted into one molecule of glucose and one of fructose. Therefore, if all the sugar in a given date were sucrose and if it were all inverted, the date would then have twice the number of sugar molecules than it had before (see p. 32, "Sugars in Dates").

Methods of analysis

It is important for the packer to know the amount of sugar and moisture in his dates. Therefore, reference is made to methods whereby he can obtain such information. Some methods, however, can only be applied with accuracy if a laboratory, suitably equipped and having trained staff, is available (Figure 10).

MOISTURE AND SUGAR

A hand refractometer (Figure 11) is practical for dates that are soft enough to be readily mashed into a paste. Its use is easy, though it takes a little time to get used to it. Its reading will give the packer the percentage of total soluble solids, which consist chiefly of sugar. The insoluble solids do not affect the reading. Therefore, the percentage of moisture is obtained by subtracting the figure read from 100. More precisely, 100 – percentage soluble solids gives insoluble solids + moisture. The refractometer gives an exact reading for a pure sucrose solution, but for date paste it is only approximate. However, by the results of moisture determinations made by the vacuum oven method, the small correction factor for use with the refractometer can easily be found. A moisture determination can be made in less than a minute after the sample has been prepared (see appendix 5); and, when the proper varietal correction has been made, the value will be within 0.5 percent of the vacuum oven method, to be described later.

To prepare the paste from dates which are hard and dry, it is necessary to mix the dates with water. In this case, dates and water must be weighed accurately, for which purpose an analytical balance is needed.

Bidwell and Sterling (1925) introduced a quick method to determine the moisture content of dates, by boiling the material in xylene (for which toluene was later substituted because of its lower boiling point) and measuring the amount of water that is distilled (see appendix 6).

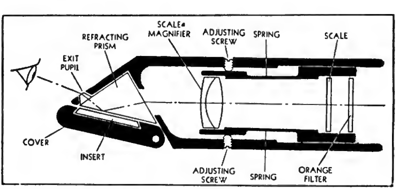

FIGURE 11. – A hand refractometer which can be used to determine total solids and moisture content of dates. Rochester, New York, United States.

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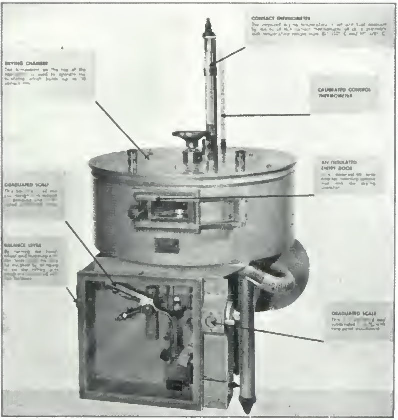

FIGURE 12. – Brabender rapid moisture tester. Duisburg-on-Rhine, Germany.

The hand refractometer technique as well as the toluene method, although both permitting a rapid determination, usually give a slightly too high moisture content. For this reason, these methods should be calibrated against the vacuum oven method (appendix 7).

Even with drying under vacuum at a relatively low temperature in the electric oven, the determination of water in dates is influenced by details of technique and by the composition of the date. Nevertheless, the vacuum oven provides the most accurate means known for the determination of the amount of moisture.

The packing house, however, seldom has a laboratory on its premises. Where possible, occasional checking of the results obtained by simpler means in the packing house against analyses of duplicate samples made in a professional laboratory is a useful safeguard against producing dates either too dry or too wet for market.

The Brabender rapid moisture tester (Figure 12), or a similar type, is useful for the packing house because it can be used by a less skilled worker than is required to conduct vacuum oven tests. It also gives results much more rapidly. It has, however, the disadvantage that its determinations are not absolute, and its results have again to be compared with those obtained by the standard vacuum oven method. Once the results have been compared, a correction factor for each variety of dates can be established.

Detailed instructions for the analysis of sugar in dates are given in appendix 8.

Dates may remain in the *khalaal* stage for two months, during which time the color change may be only slight, while the accumulation of sugars will have been great. Therefore, it is not always easy to make a reliable estimate of the sugar content by judging the depth of color of the skin. It is, however, important for the Daglat Nuur packer to know the approximate sugar content of the *khalaal* he receives. Vinson (1911), Postlethwaite (1936) and Nada (1955) have pointed out, that by using the specific gravity of the *khalaal*, one can quickly and simply make a rough estimate of the amount of dry matter which the date contains, and hence know somewhat more roughly its sugar content.

The table in appendix 9, adapted from Nada (1955), shows the correspondence between the specific gravity of the common Egyptian date (Haiyaani) and its sugar content.

SOME CONSTITUENTS OF THE DATE PIT

A few analytical data of some of the constituents of the date pit are given in appendix 10.

3. FIELD OPERATIONS

Harvesting

The way in which the dates are harvested affects the packer directly. If they are harvested in a clean way, the packer is saved the labor of cleaning, while if they are allowed to fall on the ground and pick up soil and sand, the packer is given the extra work of removing the added dirt. Furthermore, the time and method of harvesting and the care given to it, largely determine what processing is required.

One of the difficulties with which modern date-packing houses in various countries have to contend, and one which adds considerably to their operating costs, is the poor state in which the dates arrive at their doors, due to improper harvesting methods. The aim of agricultural extension services in date-growing districts should therefore be to encourage the use of garden boxes and the placing of dates directly from the palm into the box.

REACHING THE DATES

There is no difficulty in reaching the dates on low palms, but most date palms are tall and have to be climbed.

Palms may be climbed barefoot, which is the usual way, but it is tiring, risky and makes carrying implements up the palm and their use at the top difficult. Footholds may be scooped out of the trunk of a tall palm to assist climbing (Figure 13).

Sometimes a man will climb a palm unaided, carrying a rope with him with which he will support himself when he reaches the top. Sometimes he will also use a simple rope belt while he climbs (Figure 14).

An improvement on the simple length of rope is the *wasla* of Libya (literally, that which causes one to arrive), which consists of a stout rope to encircle the palm, and a large number of small ropes for supporting

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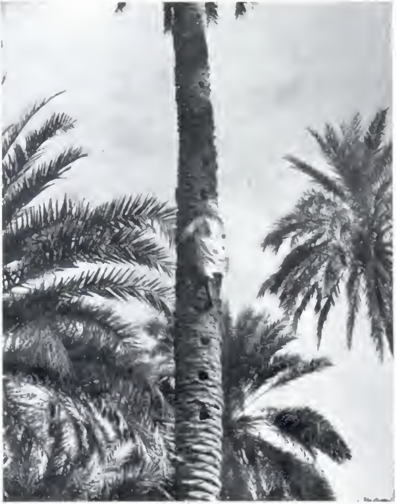

FIGURE 13. – Footholds are scooped out of the trunk to assist climbing. Madwein, Libya.

the climber's back. The small ropes are made into two big loops at the ends. To one loop, one end of the thick rope is permanently attached, and the other end is tied to the other loop before its user starts to climb. This belt is also used in Algeria.

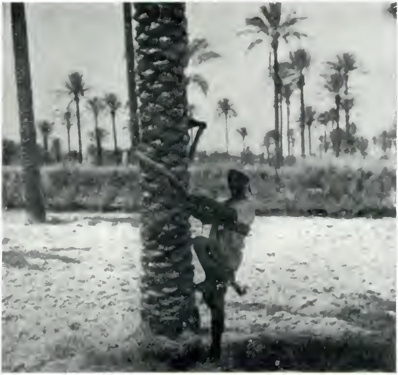

FIGURE 14. – Simple climbing belt and axe for pruning, as used at Zaawiya, Libya.

An improvement on the *wasla* of Libya is the *farwand* of Iraq (perhaps from the Persian word *parwandeh*, meaning rope). *Farwand* is also the name in Khuzistan (Iran), *parwan* in Bushire (Iran), and *parbun* in Panjgur (Makran, Pakistan). In Kech (Makran, Pakistan), however, the belt is called *tor*, in Bahrein *karr*, in the Yemen *markadh*. In the Hejaz (Saudi Arabia), it is known as *marbata*, that which is tied. The Iraqi *farwand* nowadays has a wire rope round the palm and a wide belt woven out of coir. The end of the wire is tied to a wooden peg which is inserted in the rope loop. The short rope with which the two ankles are tied together, used sometimes for climbing the coconut palm, is not used for dates.

It is generally the men who climb the date palms, but the women, as well as men and children, collect the dates from the ground. At Darj, near Ghadames in Libya, however, the women of the negro cultivators climb the palms as readily as the men.

In the United States, the date farmers are reluctant to remove their shoes and socks and to shin up a palm barefoot. Instead they employ mechanical devices. While their palms were still short they used ordinary three-legged stepladders such as are used for picking stone fruit.

As the palms grew taller, wooden picking platforms (Figure 15) were suspended by chains from the crown of the palm, a ladder was left more or less permanently hanging from the same place, and the date picker had to carry round with him only a comparatively short ladder to enable him to reach the bottom of the hanging one.

Picking platforms, as well as being somewhat costly, are cumbersome to raise as the palm grows taller, and another device was tried, an extensible ladder on flanged wheels, which ran on a circular railway line built round the palm. A chain from the top of the ladder encircled the palm and prevented the ladder, which was tilted away from the palm, from falling.

A later development was the use of the extensible tower, like those employed by tramway authorities for repairs to overhead wires, built on a lorry or on a four-wheeled chassis towed behind a tractor. Several were made and used, but falling prices for dates and rising costs after the second world war and the employment of modern aluminium alloys for ladder manufacture, have caused their use to be discontinued. The 40-foot ladder that can be carried by one man is now widely used in the United States (Figure 16).

DETACHING THE DATES

For household use, the owner will pick the *rutab* dates one by one, and in the United States large quantities of *rutab* Daglat Nuur are still picked in this way despite the recent large increase in the size of the crop. Dates picked one by one and placed in a receptacle do not become squashed or dirty, but such picking is slow and laborious. They become somewhat more squashed when placed inside the picker's shirt.

Dates seldom ripen evenly on the bunch, though the hotter the climate the shorter the time between the ripening of the first date and that of the last one on the same palm. In marginal lands, as much as two months may elapse between the appearance of the first *rutab* date and that of the last one on the same palm. In these places frequent hand

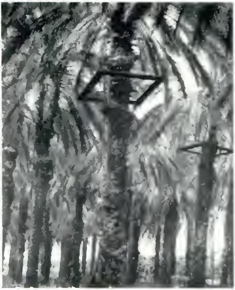

FIGURE 15. – Picking platforms as used in California, United States.

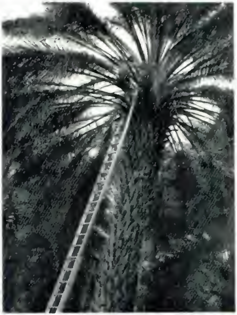

FIGURE 16. – The 40-foot light ladder in use in California, United States.

picking ensures almost uniform maturity in each consignment received by the packing house.

Shaking the bunch by hand will cause the *rutab* and *tamar* to fall (Figure 17), while the *khalaal* will remain attached to the spikelets, that is, to the stalks. If a receptacle is placed under the bunch, the dates will be caught and will not become dirty. Often, however, to save trouble, the cultivator will shake the bunches where the dates are mostly *tamar* without holding a basket below. The dates will fall to the ground and the *rutab*, being sticky, will pick up dirt.

At Tump and Panjgur in Makran, the *rutab* are either shaken into a basket or into a piece of cloth tied to the cultivator's waist. The opposite edge of the cloth is stitched to a stick, to the middle of which a hook is attached. The cloth is stretched out under a bunch and the hook is slipped over a frond on the side away from the cultivator.

In Makran, also to prevent dates falling from the bunch to the ground and being spoiled or lost, a jar-shaped basket called *sund*, woven from leaflets of the dwalf palm, is put over the whole bunch, and a string, made of leaflets of the same palm, pulls the neck tightly round the main axis of the bunch. After three weeks or so, the whole bunch is cut off, together with the basket.

Cutting off the whole bunch is the harvesting method used for the greater part of the date crop (Figure 18). A small, toothed sickle is commonly employed for cutting through the main axis.

LOWERING THE DATES TO THE GROUND

If the dates are *tamar* and, therefore, moderately hard and not sticky, the ordinary way of getting them from the top of the palm to the ground is by throwing the whole severed bunch down (Figures 19 and 20). Mats or sacking may, or may not, be placed on the ground.

In parts of the Sahara, in Tunisia, and in Ghadames in Libya, a chain of men, from the crown of the palm to the ground, passes each bunch down by hand. The men are usually cultivators of neighboring plots who, after finishing one plot, go in a group to the next one, until all the dates belonging to the whole group are harvested. No implements are required, except the sickle, and the dates reach the ground clean and undamaged.

In Mexico, the bunches of *khalaal* may be slid down a rope (Figure 21).

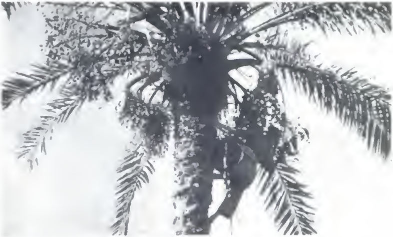

Figure 17. – Shaking the bunch of the Bikraari variety by hand. The *rutab* and *tamar* will fall to the ground. Zliten, Libya.

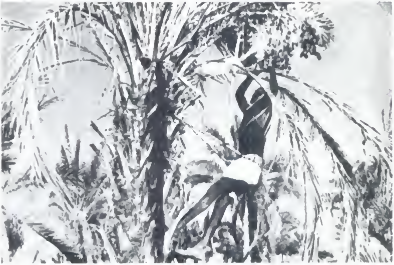

Figure 18. – Cutting the whole bunch. Baraak, Libya.

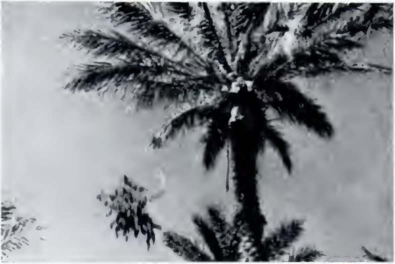

FIGURE 19. – The bunch in mid-air. Baraak, Libya.

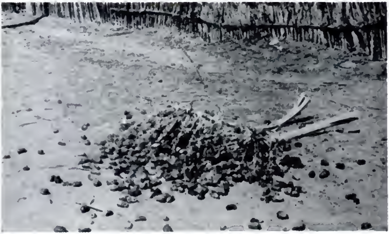

FIGURE 20. – The bunch on the ground. Baraak, Libya.

In Iraq usually, and in Libya often, the bunches of *khalaal* and *rutab* dates are lowered on a crutched stick (*maglas*, that which is attached, in Iraq; *makhtaf*, hook, in Libya) tied to a rope (Figure 22). A man on the ground removes the bunch and places it on a mat and the harvester hauls the crutch up again by the rope. It has been reported that the crutched stick has been modified in eastern Baghdad (Baquba area) to a lever pulley type that does not have to go down with the rope. Only the bunch goes down and the pulley remains temporarily tied to a leaf base. It is a convenient piece of equipment that can still further be improved to make the lowering of date bunches an easy operation.

COLLECTING THE DATES FROM THE GROUND

When the bunch is thrown to the ground, most of the dates fall off it through the force of the impact. Those that remain are removed by shaking the bunch or, if that is not effective, by picking them off the spikelets one by one (Figure 23).

In the Fezzan, the dry dates are thrown directly onto the sand. In Iraq, the bunches are usually thrown onto small mats woven from date leaflets, but many of the dates fall outside or bounce off the mat.

An improved mat was adopted in a big plantation in Basra. It was larger than the ordinary one and wider at one end than at the other. The two side edges were sewn over to make hems into which two short lengths of light bamboo were inserted. These provided an easy means of tipping the dates off the mat at the narrower end into the fields boxes (Figures 24 and 25). The mats, being narrower at one end than at the other when placed side by side, made sectors of an annulus and could thus be set round the trunk of the palm. If mats are not available, old sacks or sacking are often used.

When the main crop of dates is picked up from the ground or from a mat, the windfalls are commonly collected also and mixed with them. As the windfalls are generally infested and the cut dates are not, it would be better to keep the two lots separate. This can be done when the grower is his own packer. Otherwise the grower has no incentive to keep them separate, unless an infestation count is made of each parcel at the packing house and the purchase price made to vary inversely with the degree of infestation. This is a recommended practice for packing houses.

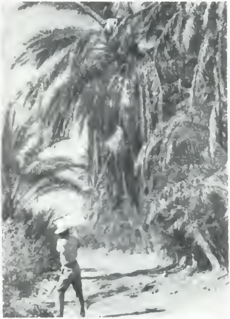

FIGURE 21. – Lowering bunch on rope. Baja California, Mexico. (Courtesy Mr. Roy W. Nixon).

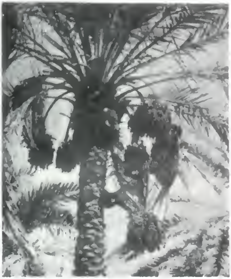

FIGURE 22. – Lowering dates on crutched stick or *maglas* (that which is attached) at Amaara, Iraq.

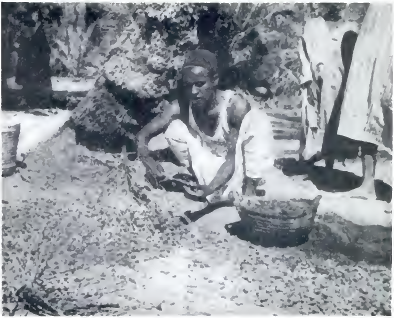

FIGURE 23. – Bunches of Aukali thrown from palm onto sand. Dates that remain on bunches are removed by picking off the spikelets one by one. Idri, Libya.

FIELD CONTAINERS

The ordinary field container is a basket made out of a long, narrow strip of matting sewn onto itself spirally. The matting is woven from date palm leaflets, and the reason it is in a narrow strip is because the leaflets are short. Handles of date palm fiber are sewn into the rim of the basket on either side. In more expensive baskets, for greater strength, the fiber of the two handles is continuous from one to the other. It is sewn through the matting down one side, under the bottom, and up the other. Sometimes baskets made of esparto grass are joined together to make panniers (Figure 26).

If the dates are hard and dry, they are generally put straight into sacks (Figures 27 and 28) either of hard-wearing wool that lasts for years, or nowadays, often into gunny bags.

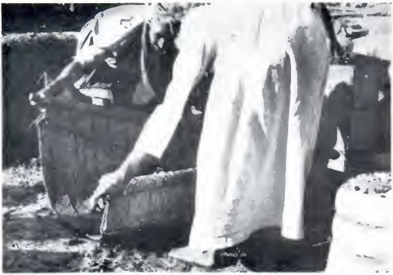

FIGURE 24. – Istaamraan (Sayir) thrown on palm leaflet mats, supported by bamboo rods at either side. Basra, Iraq.

In the United Arab Republic, where in Cairo and other large towns there is a large consumption of *khalaal* and *rutab* dates, these are usually put straight from the palm into rigid crates made of the dried midribs of palm fronds. The dates go to market without change of container.

The huge Basra crop, most of which is exported, is generally collected directly from the palms in wooden boxes; and it is in these containers that the dates are subsequently transported to the packing stations without further handling. Most of the dates never touch the ground, and those that do pick up remarkably little dirt, for the ground at harvest time is extremely hard and dry.

These boxes measure 24 × 28 × 49 centimeters, externally, and hold 1/30th of a cubic meter of dates, equal to 17.5 kilograms of loose dates and 32.5 kilograms of packed dates. This is the standard size for the export trade to the United States The dimensions of the United Kingdom standard size are slightly different. The packers send the cases out to the growers; when they are returned full, the packers empty them.

In Algeria and in Tunisia, much of the Daglat Nuur crop goes to the packing house on the bunch. For that part which is boxed, since the dates are not in the *tamar* stage as are the Basra, a shallower box is preferred. A box of about the same dimensions has also been adopted for the Daglat Nuur in the United States.

Field grading

During harvesting there is usually some grading (Figure 29). *Hashaf* (shrivelled), *humeira* (which means the little red one), small, spherical dates, with small pit with a little dried flesh round it and papery red skin, and *khaiyis* (rotten) dates, are collected for cattle feed and thrown into a special basket. *Khalaal* are thrown into another basket, to be eaten fresh by the cultivator and his family, and the *rutab* into yet another. The latter will be spread in the sun to dry down into *tamar*.

Where dates are delivered to the packing house still on the bunch, as is much of the Daglat Nuur crop in North Africa (Figure 30), there is not much grading in the garden.

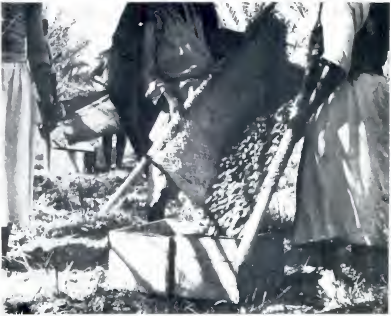

FIGURE 25. – The dates are tipped from mat into quarter *mann* boxes. Basra, Iraq.

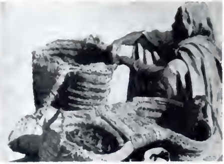

FIGURE 26. – In Libya, similar baskets, but made of woven esparto grass, are sometimes joined together to make panniers. Zliten market, Libya.

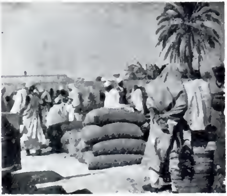

FIGURE 27. – Jute sacks for dry dates in Tripoli market, Libya. Baskets made of date leaflets on the right.

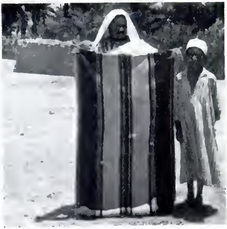

FIGURE 28. – Sack for hard, dry, desert dates, made of wool, mohair, and camel hair. Maraada, Libya.

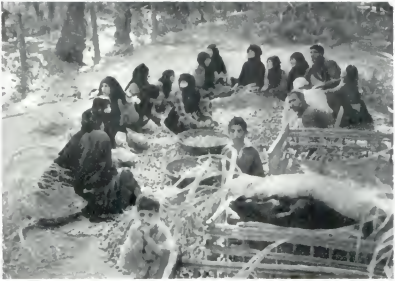

Figure 29. – Field grading of Zahdi. Baghdad, Iraq.

In Basra, on the other hand, dates from the palms are usually carried in their boxes to a central collecting point in the garden known as a *jaukhaan*. If the crop is small and the packers are eager for dates, there is no further grading, but if the crop is large and packers are in no hurry to buy, then growers will often practice a second grading out of rejects in the *jaukhaan*.

In Baghdad, where most of the date crop is of the Zahdi variety, much is cut and carried on the bunch either as late *khalaal* or as *chasib*, which, as has already been mentioned, is a date that has dried straight from the *khalaal* stage without ever having been a proper *rutab*. In a Baghdad *jaukhaan*, therefore, there may be moderately thorough grading, with the *khalaal* left on the cut bunch to mature, the soft dates selected for stamping into baskets or pressing into skins, and the *chasib* picked out for sale loose. At the same time the refuse is thrown into a basket for the cattle.

On the coast of Libya, the dates are well graded in the gardens, first during the preliminary cutting in two; afterward, when the dates are turned over or collected for the night, bad dates are removed and given to the cattle. Moreover, during the growing season, windfalls are eaten from under the palms by the sheep or are collected by the children for the sheep's evening meal, so that there is not much admixture of rotten and wormy windfalls with the main harvest.

Ordinarily there is no cleaning in the field, and the only notice of such a practice in the literature is in Brown, T. W. (1924), who states that the Aglaani dates grown at Salhiiya in the Sharquiiya Province (United Arab Republic), are dipped in water before packing, in order to remove any adhering sand.

Field pitting and capping

PITTING

Pit is the term commonly employed in the United States for a date seed, and stone in the United Kingdom. In the United States, therefore, packets of dates which have no seeds in them are marked " Pitted, "

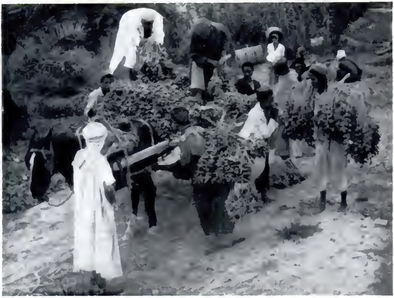

FIGURE 30. – Transport of dates on the bunch to the packing house by cart. Tunisia. (Courtesy Derocles and Cie. Tunis)

but in the United Kingdom " Stoned. " At least one British packer improved upon this, perhaps by analogy with words like decorticated, and advertised his dates as " Destoned. " This led a perplexed member of the House of Commons to ask during a debate on proposed alterations in customs duties whether a destoned date was a stoned one that had its stone put back again.

The pit is called *fasma* and also *nawaiya* in Iraq and in Hasa (Saudi Arabia), *ajma* in the Hadhramaut (Aden Protectorate) and Oman Sultanate, *qazzi* in Djibouti (French Somaliland), *nawaiya* in Libya, and *alfa* (fodder) or *adham* (bone) in Marrakech (Morocco).

Field pitting is generally the women's job. For the most part they pit in the gardens, but the work may be done on the house roofs where the dates are drying in the sun.

There are several ways in which the pit is extracted. In the United Arab Republic, when soft dates are being prepared for *agwa*, which is pressed into earthenware jars, the pit is squeezed out of the date between the finger and thumb and, at the same time, the skin is slipped off.

The teeth are frequently used for extracting the pit. In Libya, where the pits are removed when the *khalaal* are split in two before sun drying, the two operations are frequently performed at the same time by crushing the date between two stones.

In the United Arab Republic, in Makran and Iraq, a small knife is also used. In Iraq, the only pitting done in the gardens is that for the supply of packers who may not have enough labor in their packing stations to do all the pitting required before the departure of the next date steamer for the West. This pitting is of a high standard. The date is slit with the knife down one side, the pit is extracted, and the two cut edges of the date are put together again so that the cut is not visible. Care is taken to leave no white *thaub* (literally gown, meaning the paper-like endocarp which encloses the pit) protruding.

In Darab (Iran), field pitting is done with a blunt-ended needle set in a wooden handle. The pit is pushed through the date endwise.

CAPPING

The term " perianth removal " is clumsy, but " deperianthing " is worse. In the United States, the term " calyx removal " is found in the literature, which has the advantage of being one syllable shorter but the disadvantage of being incorrect. What is actually removed is the perianth;

TABLE 17. – Different names for the cap

Country or region	Names
Makran (Pakistan)	*srumpag* or *sarampag*
Iran (Shatt el-Arab)	*anag*
Iran (in various places, but not on the Shatt el-Arab)	*bizk, katad, kofiraa, kufaal, kulaach, kulaahu, kulauk, kulahak, kulauuk, kulo, kulo-i-khurma, kurfaa, piizg, sarampok, surampak*
Iraq	*anag*
Hasa (Saudi Arabia)	*anga, gama* or *guma*
Bahrein	*gama*
Muscat	*tafaruuqa* or *qaama*
Hadhramaut (Aden Protectorate)	*qaanuub*
Hejaz (Saudi Arabia)	*dhufrag*
Sudan	*nakhara, nagruuma, qaar*
United Arab Republic	*guma*
Libya, coast	*mingaar* (beak), *sidaada, nifla*
" Taajura	*mingaar* or *anag*
" Kufra (Teda)	*kadhanu*
" Sebha	*naghfa*
" Ghadames (Berber)	*tafarshit* (plural *tafarshein*)
" Ghat (Targi)	*taasart*
" Targi	*taafugfuga*
Tunisia	*qunt*
Marrakech	*nabaata*

the calyx is only a part of that structure. Perhaps from cap-stem, which is a trade word for the dried date perianth, the words cap and capping may be made to serve by virtue of their brevity and tolerable correctness.

In the Old World date-growing regions, the cap has many names, as shown in Table 17.

In some varieties of dates the cap usually adheres more firmly to the date than to the stalk, and in others more firmly to the stalk. Dates in the soft, *rutab* stage, particularly those of the Barhi variety of Basra, when pulled off the stalk, sometimes leave not only the cap behind but the pit as well.

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Table 18 shows the differences between ten varieties of dates from the Fezzan, all harvested in the prune-like, *tamar* stage, in respect of the quality of adhesion of the cap.

From Table 18 it might have been expected that the Taasfirt date would have been the most free of sand, yet in fact it is the most sandy, because, although no sand can enter into the central cavity in 95 percent of the dates, yet the skin of this variety is brittle and breaks, and sand is, therefore, able to lodge on the exposed date flesh.

TABLE 18. – Proportion of Fezzani dates without caps to those with adherent caps, by varieties, as received at Government Date-Packing House, Tripoli, 1957 season [1]

Variety	Proportion of dates	
	without cap	to those with cap
Salaulu	10	1
Taaghiyaat	7	1
Abil	5	1
Bistiyaan Hamrai Khadhrai	3	1
Aukali	2	1
Adhwi Taaliis	1	2
Taasfirt	1	19

[1] Samples of 100 dates taken at random.

(V. H. W. Dowson)

Caps vary in the manner in which they are joined to the date. The Umm ed-Dihin date of Basra, for example, has a depressed center to its base, so that the cap is sunk as it were in a pit. The Bureim and Istaamraan (Sayir) from the same place have flat bases from which the caps protrude, while the Umm ez-Zuweiwiida (the mother of the little bit extra) of Hartha has a little eminence in the middle of the base on which the cap sits. To prevent confusion in reading the above sentence, with its appearance of illogicality, it has to be remembered that the base of the date when it is young is at the bottom, but that as the date grows its weight pulls down the stalk on which it is borne, so that it ends its life hanging upside down, with the apex (when viewed from the ground) below and the base above (Figure 31).

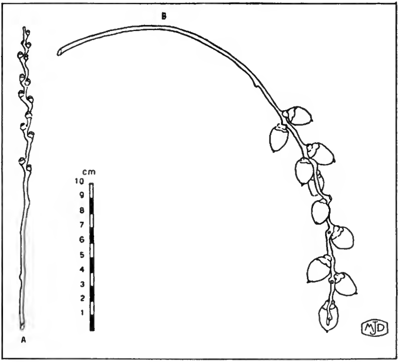

FIGURE 31. – Inversion of dates during growth. A. Spikelet, showing fruit just formed. The stalk is still vertical, the bases of the fruit are below and the apices above. B. Spikelet, showing fruit about half grown. The stalk has bent downward with the increased weight of the fruit, so that the bases are above and the apices are below.

(Courtesy Mrs. Joy Dowson)

When, in the gardens of northern Libya, the *khalaal* date is sliced in two and the pit removed, the cap may fall away from the two halves and from the pit, or it may remain attached to one of the three. The slicer should remove caps adhering to the halves, but a large number nevertheless find their way to the packing house, where they have to be removed by hand on the grading belts. In the United Arab Republic the caps are removed in the gardens when the dates are pitted for the preparation of date paste. In Iraq, the caps are not removed before the dates are pressed into baskets; but where garden pitting is practiced on behalf of a packer, the caps are, of course, carefully removed. When dates of the Zahdi va-

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riety of northern Iraq fall, or are pulled off the bunch, the caps nearly always remain attached to the stalks.

The caps are thrown with the pits during garden pitting and capping and fed to the cattle. No analyses of caps appear to have been made, but they probably consist chiefly of fiber, and undoubtedly contain none of the oil that helps to make the pit a moderately valuable food.

It has previously been noted that whether the date has or has not a cap, is of considerable difference to the packer. The reason why this is so is because the cap seals the base of the date; when the cap is removed a hole is left. When the date has a cap it is unlikely to harbor a worm; when it has no cap it is often infested. When the date has a cap and the skin is unbroken, any dirt collected on the skin is readily brushed or washed off. but when dirt has entered through the cap hole, there is no practicable way of cleaning it.

Field skinning, slicing and pounding

SKINNING

Skinning, by holding the *rutab* date between the fingers and squeezing the inside out through the hole in the base, is not a common practice, but in Makran (Pakistan) it is sometimes done for choice dates that are to be preserved in date syrup. In the United Arab Republic, dates for home consumption (Haiyaani) are sometimes first dipped into warm water, the skins are then squeezed off and, after pitting and drying in the sun, the date flesh is pressed into an earthenware jar called *ballaas*.

SLICING

The Haleni and Begum Jangi varieties of Kech (Makran) are cut in two lengthwise and then preserved in jars called *humb*. They are then known as *tallo*.

The Muzaati variety of Panjgur is cut in two horizontally and the halves threaded on strings. These strings of dates, common in the markets of northwest Pakistan, are known as *lar*.

On the coast of Libya, perhaps 30,000 tons of dates, approximately 3,000 million dates, are sliced into two longitudinally by hand every autumn in the gardens before drying.

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POUNDING

The pounding of the date is, perhaps, more of a kitchen than a field operation but, as in Kech, where it is practiced, the limits of kitchen and garden are often indeterminate. The Makrani *harag*, the equivalent of the Iraqi *khalaal matbuukh* (to be described in the next section), is pounded to a powder and mixed with fried sesame seed. It is then called *kunchi tohrag*. The dates used are the Muzaati.

Field ripening and curing

The terms ripening, maturation, curing, drying and dehydration require some explanation.

Each of the above, from ripening to dehydration, is considered to be a processing operation when it is carried out after harvest; when it occurs on the palm it is not considered to be so.

Ripening and maturation in ordinary speech mean much the same thing, but ripening gives more the idea of a continuing process, while maturation rather one of the completed process. Maturation, the grander word, tends to be more used in the packing house. For the field, ripening will do very well.

A ripe date is one in which the hard, brightly colored *khalaal* has been completely changed into the duller colored, soft *rutab*. This is a squashy, perishable fruit.

It has already been mentioned earlier that some varieties of dates always, and others sometimes, skip the *rutab* stage and go straight from the *khalaal* to a tough, generally light-colored, dry, long-keeping date known variously as *abul-khusheim*, *chasib*, *ariish*, *frezza*, etc. Here ripening and curing are telescoped into one process.

Curing implies a later process than ripening. The date ripens and then it cures. On the other hand, in the literature, it is often used indiscriminately with ripening, so that one finds articles on the home curing of dates when all that is meant is ripening. It is, however, a useful word to have for the further drying of the fully *rutab* date into the prune-like, firmer *tamar*. The *tamar* is not a perishable fruit; it is a dried fruit.

Drying and dehydration have the same purpose, namely, reducing the water content. In practice, however, drying of dates is the removal of moisture by natural evaporation, either in the sun or in the shade. In this operation there is little control or adjustment of the prevailing conditions. Dehydration, on the other hand, is the removal of moisture under controlled conditions of the temperature, the air speed, and the humidity of the air used in the dehydrator. It is to be noted that drying and ripening are not the same thing. The two processes, however, are intimately associated with each other, but they do not necessarily proceed at the same rate. They even proceed in inverse ratio during the earlier stages of ripening, that is, in the early *kimri*. The association, however, between drying and ripening in the later stages is much closer. A date can, nevertheless, be ripened without much loss of moisture, and it can be dried without being properly ripened.

Before considering ripening and curing in greater detail, six general statements are presented below. They indicate, briefly, regional climatic differences that affect these phenomena and the field in which artificial processing is useful.

1. A date properly ripened on the palm is of better quality than one picked before or after ripening.

2. A date picked before or after proper tree ripening may be processed and its quality improved, but its quality is never better than that of one properly tree ripened and is generally worse.

3. Most of the dates of the world are never submitted to any processing operation except pressing.

4. Where dates grow best, the climate is so hot that the ripening period is short and the dates ripen comparatively evenly.

5. In marginal lands, the climate is cooler and dates ripen more slowly. In such lands two months may elapse between the ripening of the first and last dates on the bunch. In still more uncongenial climates, the dates may never ripen on the palm beyond the *khalaal* stage.

6. In a very hot but extremely humid climate, e. g., that of Bahrein or of Lingeh on the Persian Gulf, the dates form excellent *rutab* but may fall to the ground before reaching the *tamar* stage.

The ripening and curing of dates on the palm are the earlier and the later parts of a continuous process; but for the purpose of a review of the treatment the dates receive after picking, it is convenient to consider them in their different stages. Therefore, the treatment given *kimri* is first described and it is followed by that given *khalaal*, and so on.

RIPENING "KIMRI"

In Makran (Pakistan), a barren country where the ripening of the date crop is eagerly awaited, the poorer people often cannot wait for the *khalaal* and they eat the *kimri.* These are first put in a basket and beaten with a stick, through which treatment some of the astringent, tannin-loaded juice escapes. They are then placed in an earthenware jar, which is wrapped in a blanket and left for a night. In the morning, the bright green of the date skin has changed to mud color, and most of the bitterness of the *kimri* has disappeared. This may be caused by the mechanical breaking down of the cells of the date with the consequent liberation of that enzyme responsible for the deposition of the tannin in an insoluble form.

Even so, these beaten *kimri* or *sorapag* (sour water), as they are called, are not thought much of by people who have other things to eat. In Basra also, in the pre-oil age, the *kimri* were treated in a similar way.

Kimri, when half grown or more, that fall from the palm to the ground, are sometimes bruised by the fall. The bruised part also turns mud colored and is then sweetish to the taste.

In Makran, *kimri,* if they have nearly reached the *khalaal* stage, are sometimes exposed to the sun on the hot sand and will complete the change to inferior *khalaal.* They are then called *pappuk rekiwar.*

Neither *sorapag* nor *pappuk rekiwar* will keep for more than a day or two, because they are too moist and contain too little sugar.

RIPENING "KHALAAL"

Khalaal are ripened artificially for one or two reasons, either because the bunch has been cut when most of the dates were *rutab* or *tamar* and the others have to be treated in such a way that they also become *rutab,* or because the climate is such that the dates, if left hanging on the palm after the *khalaal* stage, would not continue to ripen properly or would be damaged by insects or rain.

As has been mentioned, the *khalaal* is a fresh fruit and large quantities are eaten in this stage, but the fruit will keep for only a few days. What cannot be consumed in that time has, therefore, to be dried or treated in one of the ways to be described below. It is useful to recall and summarize the information already given about the water content of the date in its different stages. Subject to reservations for particular varieties and for particular climates and seasons, the following are roughly the percentages of moisture found in the various stages:

		Moisture content
Earliest	*khalaal*	85 %
Latest	"	50 "
Rutab	tip	45 "
"	50 %	40 "
"	90 "	35 "
"	100 "	30 "
Tamar		20 "

Dates in all the above stages except the *tamar* are perishable fruit, but the less the moisture content the more days they will keep. *Tamar* dates are the only ones that will keep indefinitely.

Insofar as the *khalaal* is concerned, therefore, drying has to reduce its moisture from 50 to 20 percent, unless the dates are to be preserved, as they usually are, by being stamped into baskets so that air and water vapor are excluded, when a higher water content (25 percent) is in some circumstances permissible. Up to 30 percent may be allowed for the paste of pitted dates stamped into earthenware jars.

It is to be noted that a reduction of moisture from 50 to 20 percent requires that 75 percent of the original moisture be lost, as may be seen from the following example, in which the original weight of the dates is assumed to be 100 grams.

Weight	of	*khalaal*	100	gm.	=	100 %
"	"	dry matter	50	"	=	50 "
"	"	water	50	"	=	50 "
"	"	*tamar*	62.5	"	=	100 "
"	"	dry matter	50	"	=	80 "
"	"	water	12.5	"	=	20 "
50 gm. - 12.5 gm. = 37.5 gm. of 50 gm. water					=	75 "

From the statement presented above, it can be observed that the earliest *khalaal*, that is, the date that has just changed its color from green to yellow or to red, contains over 80 percent water. If picked from the palm at this stage, it cannot be turned into *rutab*. *Rutab* can be made

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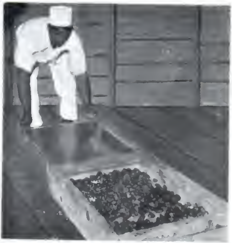

FIGURE 32. – Drying of *rutab* under glass in rural packing house. United Arab Republic.

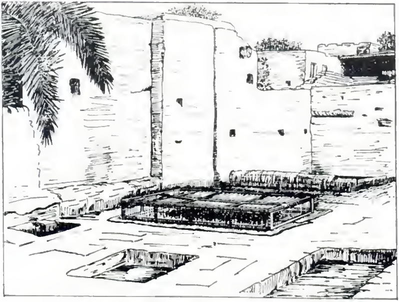

FIGURE 33. – Drying *rutab* on roof in rural packing house. Chicken-wire cage keeps off sparrows. United Arab Republic.

(Courtesy Mrs. Joy Dowson)

only when the changes of color from yellow or red to brown and of texture from firm to soft have begun at some point on the date, or when such changes are imminent. If these changes have begun, or are about to begin, they will continue, if the picked date is kept warm, until it is soft all over, that is to say, until it is fully *rutab* (Figures 32 and 33).

SIMPLE SPREADING IN THE SUN

This ripening process is practiced in the gardens and on the house tops from Marrakech (Morocco) to Multan (West Pakistan). The *khalaal* are spread on mats one layer deep and exposed to the sun (Figure 34). At night and in rainy weather they are heaped up and covered, or brought into the house, hut, or tent. Sometimes the *rutab*, as they form, are picked out and marketed, but usually the dates are left until they all become *tamar* or near *tamar*. Ripening and drying may last from three days to three weeks, depending upon circumstances, but a week is probably the most usual period.

In some places, such as the United Arab Republic, for example, drying grounds (called *mansharaat*, from *nashara*, meaning he spread out) with temporary matting walls are made in the gardens. On the south coast of Arabia, they are generally on the hard soil or rock outside the gardens and surrounded by permanent mud or rock walls 1.5 to 2.5 meters high. They are known as *duruua* (singular *dira*). On the coast of Tripolitania (Libya), the dates are dried on mats on the ground at any convenient place in the gardens and are not protected by walls, either permanent or temporary (Figure 35). As much of the harvesting is done by the nomads who pitch their tents among the palms, they often prop up the eaves with sticks and spread their dates to dry in the slack.

In Mexico, the drying mats are usually on rough platforms about a meter above the ground; in Tibesti (Chad) a small platform, generally made of the trunks of the duum palm and called *angeli* is used. The Teda (Libya) date owner usually takes his afternoon nap under it, thereby securing shade and guarding the dates at the same time; and in the mosquito season he will often sleep at night on top of the platform. Figure 36 shows drying stands and drying trays as used in Talesi Bagh, Muzaffargarh, West Pakistan.

BLACK SHEDS

A refinement of the sun-drying process has been introduced by some of the French Daglat Nuur growers of south Tunisia, who put the *khalaal*

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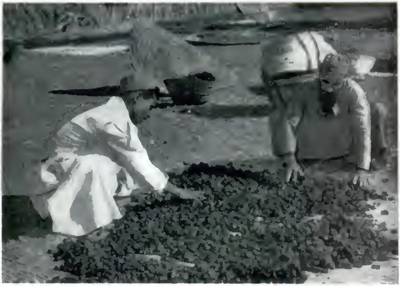

FIGURE 34. – Drying dates on mats. United Arab Republic.

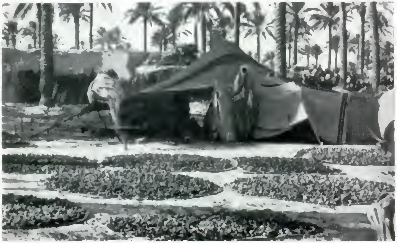

FIGURE 35. – Beiyuudhi, Taabuuni and Bikraari pitted halves drying on circular mats (called *badaaraat*) on sand. Zliten, Libya.

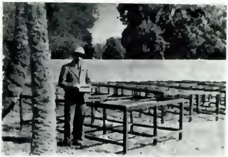

Figure 36. – Drying stands and trays, and agricultural overseer, Muhammad Munir Khan, with ½-pound date carton. Talesi Bagh, Muzaffargarh, West Pakistan.

onto wire mesh trays, which they then stack in corrugated iron sheds painted a dull black on the outside. The temperature inside the sheds rises very high, and the nightly labor of covering the dates or bringing them indoors is avoided.

Shrivel

Some of the *khalaal* spread out to dry will not ripen properly but shrivel. These are picked daily and fed to the cattle. Even *khalaal* on the palm will sometimes shrivel if exposed to a too dry and too hot wind. To prevent such shriveling, the Yamani date farmers in the Toeg Hanbali near Djibouti, French Somaliland, wrap up their bunches of *khalaal* in rags and palm fiber as soon as the fierce, scorching winds of the *khariif*, the southwest monsoon, begin to blow. The farmers, in effect, thus retard rather than promote ripening.

In some places in Fars (Iran) the bunches of *khalaal* are also wrapped but with dried bushes. The protection thus provided is more to keep off the rain and only secondarily to keep out the hot winds.

Split dates

So far there have been considered *khalaal* which, when picked as such and spread out in the sun, will ripen into *rutab* and *tamar* without further treatment. These are the *khalaal* of lands where the sun is hot enough to bring about such ripening and where only the drop in temperature or heavy dews at night have to be guarded against; but there are other places where day temperatures are too low to allow the date to dry before fermen-

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tation sets in. Such places are the coast of Tripolitania (Libya), the island of Djerba (Tunisia), and the Punjab (Pakistan), where the *khalaal* will not dry quickly enough unless they are cut in half.

From a study of the literature, the permeability to water vapor of the unbroken skin of the *khalaal* between the stomata does not seem to have been determined, but it appears to have been assumed that it is virtually impermeable and that evaporation from the date takes place only through the stomata. As there seems no reason to doubt this assumption, it is clear that the cut surface of the flesh of the date must allow evaporation at a very much greater rate than through the skin of a whole date.

The labor of cutting each date longitudinally in two by hand, performed daily by the owner or tenant and his family, is enormous, but a moderately well-keeping date is produced when the halves, after drying for a week or so, are properly stamped into baskets. The great disadvantage of this slicing, however, apart from its employment of much labor, is that, whereas sand blown onto the shiny surface of the whole date can be readily blown off again, when it blows onto the cut surface of the date flesh it sticks there, and the more the date dries, the more firmly does the sand adhere to it. The halves are dried on the ground (Figures 37 and 38) and not on raised platforms, and since the ground is sandy and the drying grounds are not protected by walls, the amount of sand collected by the dates is enough to make them very gritty to eat.

Almost everywhere along the Tripolitanian coast the commonest date is the Bikraari, so that this is the date most usually found in the coastal markets in dried, slit halves, pressed into baskets.

On the island of Djerba (Tunisia), the Limsi dates which are not eaten fresh are also split and dried, though they are generally pressed into earthenware jars and not into baskets. The Limsi is the commonest variety there to be so treated.

At Muzzaffargarh in the Punjab (Pakistan), it is the Ghatti date which is the one commonly split before drying. The pit may or may not be removed. Dates dried in this way are known as *chirvi* or *shingistan* (compare the *tamar* of the Libyan coast).

RIPENING AGENTS

In the Arab marginal lands, vinegar is occasionally used to hasten the ripening of *khalaal* at the beginning of the season, when the price of *rutab* in the market is high; but the resulting *rutab* is not as well flavored as that

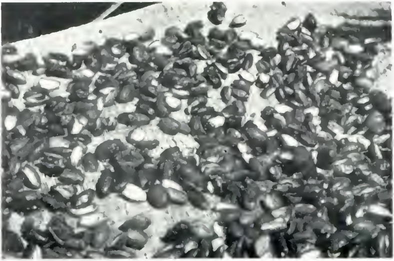

FIGURE 37. – Split Bikraari halves, the commonest date on the Tripolitanian coast, Libya, drying in the sun on mats raised off the ground on stands, in a clean-drying experiment.

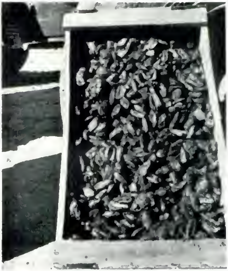

FIGURE 38. – Bikraari sun-dried, pitted halves; 15 kilograms in lug box. Tripolitanian coast, Libya

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of normally ripened dates. This use of vinegar is, however, the standard practice for those dates in Elche (Spain) which are not eaten as *khalaal*, but which will not ripen into *tamar* when cut from the palm and hung in the open to dry. These *khalaal* are sprinkled with vinegar and then kept in a closed barrel or other container for about a day. When they are taken out they have mostly become *rutab* (Sp. *adobado*, incubated). The same practice has been followed with the Egyptian dates Haiyaani and Samaani in Israel. Spraying the bunches on the palms with a weak vinegar solution has also been tried there.

Brown, T. W. (1924), who mentions the use of vinegar in Lower Egypt, states that *khalaal* in the Giza province are steeped in salt water to hasten ripening. Barakzai (1920), Siddiqui (1951), and Nada and Hassan (1955) also refer to the use of salt water for ripening *khalaal* dates.

PRESERVATION IN SYRUP

Khalaal are sometimes preserved in date syrup. Although they are preserved they have not been ripened, but the process is also mentioned here.

In the United Arab Republic, the Amhaat date is the one usually maintained in this way, but the quantity of dates so treated is small. The dates are put in an open vessel, covered with syrup, and exposed to the sun for from 20 to 30 days, the syrup being replenished as necessary. Because the syrup excludes the air, the dates retain their bright yellow color and something of their hardness and, having absorbed much syrup, are excellent for eating.

In Makran (Pakistan), the Sabzo date is cut into pieces when in the *khalaal* stage and is then preserved in syrup in jars; in that form it is known as *chuptagen kulont*, as has already been mentioned in the section on " Slicing Dates. "

" KHALAAL MATBUUKH " – MEANING OF NAME AND ESSENTIALS OF PRACTICE

As has been stated earlier in this study, *khalaal* is the Iraqi word for the date in its hard yellow (or red) stage. *Matbuukh* means cooked. *Khalaal matbuukh* are yellow (or red) dates that have been boiled and then dried, until they become very hard and wrinkled. In this stage they will keep indefinitely. They are sweet and their taste and consistency are reminiscent of the old-fashioned sweet called fondant.

Distribution of practice and names of product

The boiling of *khalaal* is practiced from the Punjab (Pakistan) to Hasa (Saudi Arabia) but is unknown in North Africa.

At Lyallpur (West Pakistan), the boiled date is called *chhohaara* or *chhoaara;* in Muzzaffargarh (West Pakistan) *chiirwaan*, cut in two before boiling, or *bhuugaari*, not cut (Milne, D., 1918, has *bhugrian*); in Makran (Pakistan) *harag* (the Muzaati date is used); in Iran (Minab, and in many other places) *khaarak* or *kharak* (the Hallo, Murdasing, Shahaani, Shakar Paara and Zarag dates and others are used), (Shatt el-Arab) *khalaal matbuukh* (the Chibchaab [= Kibkaab] and Bureim dates are used) ; in south Iraq, *khalaal matbuukh* (the Chibchaab and Bureim dates are used); in Hasa (Saudi Arabia), *khalaal matbuukh* or *saluuq* (Figure 39) meaning boiled (the Ruzeiz date is used). In Muscat (Saudi Arabia), the Mabsali is the date most commonly cooked. Here the stove (*tinkba* or *cheirkhaana*) is elaborate and permanent. The cooking pot is called *masjal* (Figure 40); the cooked date is called *bisaal.*

Description of process

The bunches of *khalaal* are cut a few days or perhaps about a week before they would normally have begun to soften, that is, to change into *rutab*. On a large estate in Basra, cutting the Bureim *khalaal* began in the years noted on the dates specified and finished a few days later. Generally, the Bureim *khalaal* were cut about ten days before the first Hallaawi *tamar. Chibchaab* is cut somewhat later than Bureim.

1931	15 August
1932	10 "
1933	19 "
1935	19 "
1936	22 "

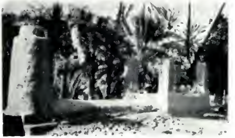

FIGURE 39. – The fireplace and chimney of the stove used for cooking hard, yellow dates (*khalaal*) to turn them into hard, dry, long-keeping dates (*khalaal matbuukh* or *saluuq*). The four pillars are to support a mat roof to keep soot and cinders from falling into the cauldron. Baatina coast, Muscat.

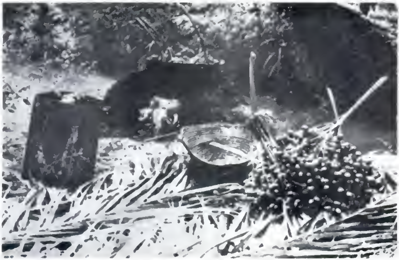

FIGURE 40. – Cooking Bureim *khalaal* to make *khalaal matbuukh.* Nahar Dihchaan, Iraq.

The dates are pulled off the bunches and tipped into a tinned copper cauldron, holding from 1 to 2 hectoliters, and half filled with boiling water. The water is kept simmering from 20 to 40 minutes. (Dowson, V.H.W., 1922, is in error when he says one to two hours.) The dates are taken out of the boiling water when the bright yellow of the *khalaal* has changed evenly all over to the dull honey color of the cooked date, and the flesh, from being quite hard, has become slightly compressible. They must be removed from the water well before the skin begins to break or flake off. When cooking is finished, the pit (at least in the Bureim) should be reddish. When this point is reached, the dates are baled out with the *misfaa*, a long-handled strainer, usually made of date fiber rope, and drained on a mat. They are then spread out to dry – care being taken that they do not touch each other – on specially prepared ground (Figure 41). Nixon (1953) observed at Qatif (Saudi Arabia) the preparation of Khuneizi *khalaal matbuukh.* These dates were all being dried on mats and in one or two layers of thickness.

By the end of August, the clay soil in the date gardens of Basra has become baked so hard by the sun that it is difficult to break. Therefore, after the drying ground has been dug, the surface clods are broken

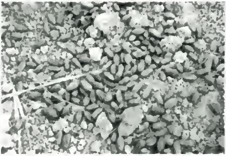

FIGURE 41. – *Khalaal matbuukh.* Boiled *khalaal* of Chibchaab (Kibkaab) variety drying on ground in half shade. Khorramshahr, Iran.

further, by means of a long-handled mallet, into small lumps 2 or 3 centimeters in diameter, and it is on these that the *khalaal matbuukh* are dried. The drying ground is under the palms, that is, in the half shade, and the dates are further protected against too much sun by having dried *halfa* grass or dried date leaflets lightly spread over them. If the dates are exposed to the direct rays of the sun for long their color darkens. The preferred color is neither red nor black but a rich, golden brown.

The water in the cauldron in which the *khalaal* are boiled is not changed for each new batch; it is merely topped up to keep it at a constant level. Presumably, therefore, any loss of sugar from the *khalaal* becomes less with each batch as the sugar concentration in the water increases, but no analyses appear ever to have been made to confirm this fact.

However, it is probably true that almost the whole loss of weight on boiling and drying unpitted *khalaal* is due to the loss of water. If this is assumed to be the case, then on the premise that *khalaal matbuukh* weigh 50 percent of *khalaal*, and *khalaal matbuukh* halves, pitted before boiling, weigh 33 percent of pitted *khalaal* halves, it may be deduced that (*a*) the water in the flesh of the unpitted *khalaal matbuukh* is about 10 percent; and (*b*) if the percentage of water in the pitted halves is considered to be about the same, then there must have been a loss of sugar, etc., in the halves amounting to about 19 percent, as may be seen from the calculation in Table 19.

Table 19 shows that the dry matter in the flesh of uncooked *khalaal* is 32 grams and in that of cooked (*matbuukh*) halves 26 grams, that is, a loss of 6 grams, which is 19 percent of 32 grams.

For comparison, it may be added that unpitted Bureim *tamar* weigh about 60 percent of unpitted Bureim *khalaal.*

TABLE 19. – Weight of *khalaal matbuukh*

State of dates	*Khalaal* plus pit		*Khalaal* minus pit		*Matbuukh* plus pit		*Matbuukh* minus pit	
	gm.	%	gm.	%	gm.	%	gm.	%
Total	100	100	87	100	50	100	29	100
Water in flesh	55	55	55	63	5	10	3	10
Dry matter in flesh	32	32	32	37	32	64	26	90
Pit	13	13	0	0	13	26	0	0

When the dates are taken out of the boiling water they are still of the same size and shape as they were when they were put into it, and there is no crinkling of the skin, but very soon after they are spread out on the drying ground they shrivel and the skin becomes deeply wrinkled. It does not separate from the flesh but remains closely adherent to it. Unboiled *khalaal*, picked at the same stage as the boiled variety, and spread out on the ground to dry, do not shrivel so quickly nor wrinkle nearly so much. One reason for the difference in behavior may be that boiling has made the skin of the date more permeable by water vapor than it had been previously, but the way in which the increased permeability is achieved does not appear to have been studied.

In the Punjab, a little oil or ghee (clarified butter), milk or salt, is added to the water in which the *khalaal* are boiled. The literature appears to provide no reason for these additions. It may be that the first three give the finished dates a gloss. Possibly salt, by increasing the density of the water, reduces the loss of sugar from the dates; but these are only suppositions.

In 1946, some experiments were contemplated in Basra on the preparation of date powder and granules, and it was proposed to use for them *khalaal matbuukh*, because it was thought that dates in this state could be ground without further dehydration; but as these dates contained pits, they had to be pitted before they could be ground. The time taken to pit *khalaal* before boiling, soon after boiling, and when dry, is shown in Table 20.

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TABLE 20. – Time taken to pit one box of *khalaal*

State of dates	Minutes	
	Chibchaab	Bureim
Before boiling	192	245
22 hours after boiling	175	210
11 days after boiling	410	473

Bureim, being the smaller date, took longer to pit than the same volume of Chibchaab.

The time taken to pit a given weight instead of a given volume is shown in Table 21.

TABLE 21. – Time taken to pit 10 kilograms of *khalaal*

State of dates	Minutes	
	Chibchaab	Bureim
Before boiling	121	133
22 hours after boiling	93	110
11 days after boiling	266	282

It will be seen that pitting the dates shortly after boiling is quicker than pitting them before boiling, when they are harder; and very much quicker than after they have fully dried, when they are very much harder. Pitting before boiling is not recommended because of the loss of sugar.

In southern Iraq, the only dates ordinarily boiled are those of the Bureim and Chibchaab varieties, but in experiments made in 1946 it was found that Hallaawi and Istaamraan (Sayir) also made good *khalaal matbuukh.* It may be, therefore, that this product can be made from still other varieties, or even from all varieties.

The Chibchaab variety of date, also called Bughbugh in one of the villages in Iraq, which is found in all the date-growing places along the northeast shore of the Persian Gulf and in Lower Iraq, is a large date,

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but it is not esteemed as *khalaal*, *rutab* or *tamar*, because the quality at all three stages is poor. Perhaps for that reason it is made into *khalaal matbuukh*. The same reason, however, cannot be applied to the Bureim, because having little soluble tannin, it is unusually good as *khalaal*, and has a large sale as such. It makes excellent, though small, *tamar*, which is frequently basketed for home consumption.

It would seem worth while for experiments to be made in the preparation of *khalaal matbuukh* from dates which usually do not naturally ripen properly. A limited trial made in 1958 with the Bikraari from the Tripolitanian coast (Libya), gave a favorable result, but as coastal Libyans are not accustomed to eating such dates, it may be that there would be no sale.

COST, ADVANTAGES AND DISADVANTAGES

The benefits to be derived from making *khalaal matbuukh* are:

1. The production of a long-keeping fruit from a perishable one.

2. The production of a product of excellent flavor from one not equally good.

3. The possibility of shipping dates (as *khalaal matbuukh*) before the *tamar* is ready. Iraq at one time had a profitable export trade in *khalaal matbuukh* to Pakistan and India early every season. Not only was the early market secured, but because the product was not perishable, it could be sent much longer distances than the *khalaal*.

4. The securing of a higher price than for the *khalaal*. The earliest *khalaal* on the local market in any date-producing district fetch a high price, but as the quantities coming to market increase, the price falls rapidly.

Some figures from Basra in 1946, given below, although probably different from current figures, nevertheless serve to illustrate the advantage to be gained by boiling.

	£	$
	... Per kilogram ...	
Labor-cutting, carrying to *jaukhaan* (central date-collecting station in garden), pulling dates off stalks, cooking, spreading on mats	0.006	0.0168
Firewood	0.004	0.0112
Hire of mats and cauldron	0.002	0.0056
Total	0.012	0.0336

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The dates were sold at £0.043 ($0.1204) (Bureim) and £0.029 ($0.0812) (Chibchaab) per kilogram, consumption tax on the buyer, so that the net receipts were £0.031 ($0.0868) (Bureim) and £0.017 ($0.0476) (Chibchaab) per kilogram. If the weight of the dates on the bunch, as sold fresh, is reckoned as twice that of the same dates cooked, the equivalent value of the fresh dates would have been £0.015 ($0.420) and £0.008 ($0.0224) per kilogram respectively. Fresh *khalaal* were on the market at about three quarters of the above prices and, it may be mentioned for comparison, second-quality Hallaawi in baskets were sold at £0.018 ($0.0504).

The disadvantages of making *khalaal mathuukh* are the extra work, the necessity for space for drying, the possibility of loss if the cook is not skillful, and the possibility of loss by theft during drying.

RIPENING IN JARS

In the Punjab, where the monsoons come before the dates have time to ripen on the palm, most of the crop is cut directly when the *khalaal* show the beginning of softening into *rutab*. The dates are dried on mats for a few days or a week, and then sold loose on the market for early consumption without packing; but the dates which are retained and stored by the grower are usually ripened and preserved in sealed, unglazed, earthenware jars, where they develop into a dark, tough, leathery, inferior sort of *tamar*.

Thus in the Punjab, dates are put in jars in order to preserve them from rotting in a humid climate, but in the Sudan, with a dry climate, jars (*ziir*, plural *azyaaz*) are also used (Figure 42). Here, however, the purpose is to produce not a dry, but a moister product than would be obtained if the dates were left hanging on the palm.

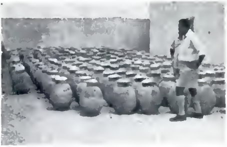

FIGURE 42. – Dates maturing in jars. Sudan.

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The explanation of the apparent contradiction in the results obtained is probably that the temperature reached within the Punjabi jar exposed to the sun is enough to kill the organisms of decay and to hasten the conversion of the starch to sugar, so that the sugar content is quickly brought to a point at which it exerts its sterilizing effect, while in the Sudan, the chief value of the jar is to prevent the rapid evaporation from the surface of the date, which occurs when it is hanging on the palm in the extremely hot and dry air.

In the Sudan, the commonest of the normal, dry dates to be jarred is the Qundeila, but Bintamauda, Kulma and others are also used. The dates are cut in the *umm nus* stage, when the basal half of the date is still hard, smooth and bright yellow (in the *sufuuri* stage) and the apical half has become brown and wrinkled. They are spread in a thin layer in the sun for about seven days, until they become brown and wrinkled (*najiidh* = mature), when culls are removed and the remainder put into earthenware jars about 2 feet high. Old jars are preferred to new ones, probably because the pores of the former are more clogged than those of the latter.

The jars are sealed with clay and exposed to the sun for another ten days, after which they are emptied. The dates are spread out again for two or three days, picked over once more, and the good dates returned to the jars where, after sealing, they remain indefinitely. The dates so preserved are sticky on the outside and certainly more palatable than the dry ones, but they are still harder and more stringy than the ordinary date of world commerce, and much inferior to it. The second sorting is apparently desirable in order to remove dates packed the first time in too yellow a stage and which might subsequently ferment; but the cultivators frequently omit the second sorting.

It is to be noted that the dates jarred in the Sudan are not, strictly speaking, *khalaal* but early mummies. the hard dates that do not pass through a proper *rutab* stage nor through a rubbery, *tamar* one. The base in the early mummy is still *khalaal*, but the apex has begun to shrivel, though without softening.

In the Fezzan and Ghadames (Libya), the use of jar storage to prevent the dates from drying hard on the palm is common, but here the dates jarred are in the late *rutab* or early *tamar* stages (Figures 43). The jars are very large and generally built into the house. They are not exposed to the sun. There is no need for them to be so treated because the dates they are designed to hold have already reached a stable condition.

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CURING "RUTAB"

Ripening *khalaal* in the sun after removal from the palm is characteristic of the comparatively cool north coast of Africa, where the dates on the whole do not form good *rutab*, but the field ripening of *rutab* after removal from the palm is characteristic of the coasts of Arabia and of the Persian Gulf, where both heat and humidity are higher, where the dates of most varieties ripen on the palm into good *rutab*, but where many fall to the ground before the *tamar* stage is reached.

Thus on the Baatina coast of Muscat, the drying ground (*mastah*), separated from the rest of the garden by a fence (*hadhiir*) made of dried palm fronds and palm fiber rope, is common. The drying grounds are beside the elaborate furnaces in which the dates are boiled to make the *khalaal mathuukh* which is exported to India and Pakistan.

Mabsali, Sillaani, Naghal and Qash Manuumah are the commoner of the varieties dried down from *rutab* to *tamar*. The commonest variety,

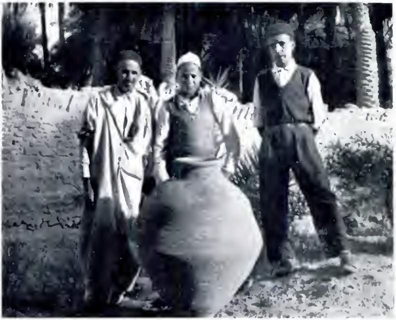

FIGURE 43. – The softer desert dates are stored in earthenware jars. Ghadames, Libya,

Umm Silla (88 percent of the palms), does not need so much drying on the ground, perhaps because of its small size and high proportion of pit (19 percent compared with 13 percent in the Hallaawi of southern Iraq), and may be stamped into baskets directly from the palm.

In Bahrein, the commonest date is the Marzubaan, which is generally harvested in a late *rutab* stage and dried for perhaps a week on mats. The drying is frequently not carefully done, the depth of the dates being too thick, possibly owing to shortage of labor. There is also loss from fermentation. The Khuneizi, the next most common date, withstands the humidity somewhat better but still needs some curing. There are, however, many varieties which are normally eaten as *rutab*, for example, the Khuwaaja, Maajiiya and Salmi, and no attempt is made to dry them down further into *tamar*, probably because they do not dry well. Hallau, on the other hand, though generally eaten as *rutab*, dries down to a good *tamar*.

In Qatif, the coast of Saudi Arabia opposite Bahrein, the Khuneizi is the commonest date and the Ruzeiz the next commonest. The usual practice is for the dates of both varieties to be harvested as *rutab* and cured for about a week on mats in the sun. The *rutab* of the former date need rather less curing than the latter, but the Ruzeiz cures into a better *tamar*.

It is evident that varieties differ in their capacity to produce good *tamar*, *rutab*, and even good *khalaal*, in unfavorable climates, so that by the selection of varieties, it may be possible to improve the general quality of the date yield in a given district. Another and quicker way to do this is by the introduction of improved drying methods, using either the heat of the sun, as in the black sheds of Tunisia, or oil-heated dehydrators, as in Libya (Figure 44).

Even in regions where dates ripen well into *tamar* on the palms, there is always a certain amount of sun drying of *rutab* to be done, because when the bunches are cut early in the season, not all the dates are hard enough to pack. Therefore, the softer ones, that is the *rutab*, have to be separated from the *tamar* and dried. The sooner this is done the better, because they then suffer less damage due to squashing. The least loss occurs when the separation is made at harvest time under the palm, when the *tamar* are put into one lot of containers, and the *rutab*, only one layer deep, into others. In the rush of harvest, however, complete separation is not always possible and the process may have to be repeated at the garden collecting point, and again in the packing house. However, by the time *rutab* are separated in the packing house, except those of the Daglat Nuur variety, which receive special treatment, as will be described

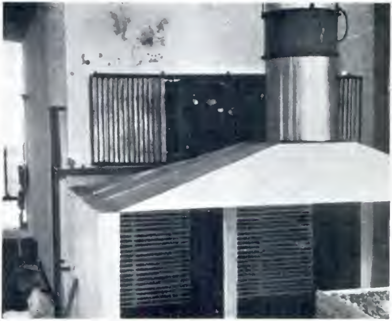

FIGURE 44. – Dehydrator, open, cold-end type. Burner is shown above the two tunnels. Capacity 6 tons. Government Date-Packing House, Tripoli, Libya.

later, they are too squashed ever to make a first-class pack. Consequently, after drying on mats in the sun, they are generally packed in baskets for a low-price market.

In the Basra packing houses, the *rutab* that have to be removed during grading are usually in a late *rutab* stage and are ready to pack in baskets by the time they have lost about 4 percent of their weight, that is, about 17 percent of their water, as may be seen from the following calculations.

Weight of *rutab* in sample	100 grams
Less weight of pit at 13%	13 "
Therefore weight of flesh	87 "
Weight of water in flesh at 28% before drying	24 "
Loss of weight on drying	4 "
Loss as percentage of flesh	5 %
Loss as percentage of water in flesh	17 "

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The curing of *rutab* need not be carried so far if the product is to be made into a paste and packed so that air is well excluded. Thus the *dastlagash*, made from Haleni and Dandari dates in Kech and from Muzaati in Panjgur (both places in Makran, West Pakistan), consists of incompletely cured *rutab*, from which skin, pits, and caps have been removed, kneaded into a paste before being tightly pressed into sheepskins or into small baskets made of the woven leaflets of the date palm. In the United Arab Republic the Haiyaani date is often similarly treated and packed in jars.

CURING "TAMAR"

In a dry, hot climate the dates dry into *tamar* on the palm. They are then no longer a fresh fruit but a dried one. When they are cut from the palm at this stage they may be packed at once without further drying, or stored in boxes until there is an opportunity for sale or packing. In the Sudan, however, where, if anywhere, one would have thought the dates as harvested would be dry enough, the ordinary practice is for *tamar* to be left lying in heaps on the sandy floor of the *shuuna*, the clearing in the garden where the dates are collected, for a month or two before they are sacked and marketed. This exposure to the sun dries the already dry dates further, but the object of the exposure is not, or not mainly, the drying but the killing of noxious insects, presumably *Pyraloidea*. Every week the heaps are turned by men with shovels, though the turning is less to ensure an even drying than to discourage attack by termites.

In the Fezzan (Libya), although there is no regular postharvest sun drying of *tamar* as there is in the Sudan, the dates are frequently left lying about in small heaps for some time before they are stored in sand pits (Figure 45). It seems that it is in these small heaps that most of the insect damage occurs, in contrast to what happens in the Sudan. The matter, however, needs further study.

Field fumigation

In the chief date-producing district of the world, that is, southern Iraq, the pests that attack dates on the palm, namely, the mite, the Lesser Date Moth, *Batrachedra amydraula* Meyr., and the Greater Date Moth, *Arenipses sabella* Hmps., have all left the palm before harvest. Therefore, if the bunches were cut, their dates put straight into boxes, and the boxes delivered to the packer before dusk, field fumigation for these dates would be unnecessary. There is, however, a circumstance which disturbs such a happy state of affairs. This is the practice of mixing together the dates which have been stripped off their stalks by hand into the boxes with those which fell to the ground during cutting, and with the windfalls that were lying on the ground before cutting began.

The Fig Moth, *Ephestia cautella* Walk., does not lay its eggs on dates on the palm, with the possible exception of those that have had their skin pierced by birds or wasps. The moth, however, oviposits on nearly every date lying on the ground without its cap (perianth), that is, on a date which has fallen from the palm, leaving its cap attached to the spikelet. The newly hatched larva of the Fig Moth cannot gnaw through the cuticle of the date and therefore makes its entry through the hole left by the absent cap. Early in the season the Grain Beetles, *Oryzaephilus* spp., are few; they attack the windfalls and stacked dates later, but every evening until the weather gets cold the Fig Moth and some of its cousins can be seen ovipositing on the harvested dates lying in heaps or in boxes.

On a large estate in Basra, Iraq, the practice was adopted of collecting all the windfalls from below the palms before the bunches were cut, and of keeping them apart from the insect-free dates shaken and pulled from the bunch. In this way the packing house was assured of receiving most of the crop from that estate insect-free. This practice, however, has not been copied, so that field fumigation for almost the whole crop is desirable.

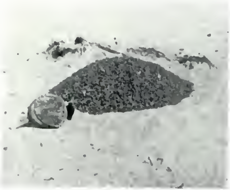

FIGURE 45. — Taasfirt dates (left) removed from pit in sand (right). On left is the seive (*ghirbaala*) by means of which the dates are sifted free of sand and the *mishah* or hoe with which the sand is removed from the top of the tip. Ummel-Hammaam, Fezzan, Libya.

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In southern California, fumigation is generally practiced as soon as possible after harvesting, not because windfalls are mixed with the good dates, but because Nitidulid Beetles infest the dates on the palm.

BUNCH TREATMENT

Lindgren and Vincent (1953) reported that the infestation by the Nitidulid Beetles, *Carpophilus* spp., that are found on the dates on the palm in California and that remain in the harvested dates, could be considerably reduced by dusting the bunches a few weeks before harvest with malathion and also with other insecticides; but as such dusting cannot properly be considered fumigation, it is no more than mentioned here.

METHOD

Tarpaulin

A tarpaulin, also called paulin, made of gastight material, can be used to cover a stack of date boxes or a heap of dates or, if the stack or heap is very big, several paulins can be used and joins made by tightly rolling the two edges together. The edges on the ground can be kept down with earth or sand, or with gunny bag sand snakes (Figure 46). The ground before stacking should be liberally sprinkled with an insecticide in powder form.

On top of a stack of boxed dates, it is advisable to have a gassing dome, that is, a space between the top of the stack and the paulin to allow space for gasification and to facilitate the diffusion of the fumigant. This is ordinarily made by four empty boxes arranged as a square with a hollow core. In the center is put the tray to hold the fumigant if it is a liquid, or the pipe outlet if it is a gas.

A convenient size of stack is one of 4 tons of dates in 210 Basra-size date boxes, stacked seven high, because that height is the highest a man can conveniently reach when stacking. A paulin for a stack of this size, including allowances for the gassing dome and for a 50-centimeter flap all round on the ground, would measure 6.5 × 8.5 meters.

Paulins of canvas are being rapidly replaced by those of lighter, plastic material.

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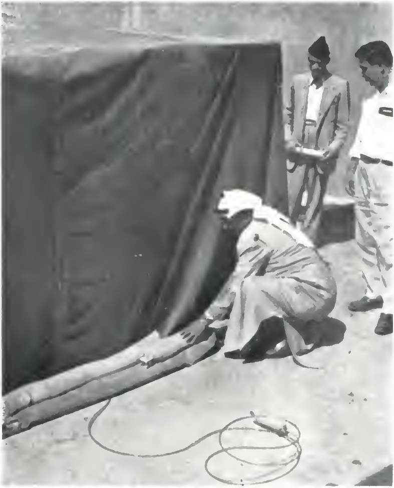

FIGURE 46. – Putting sand snakes round stack of date boxes before fumigation with methyl bromide. Date Association Packing House, Baghdad, Iraq.

Box

A nylon paulin coated with neoprene and of the above dimensions is expensive. A much cheaper device, and one that is quicker to put over and to remove from a stack, is a box consisting of a light, wooden frame,

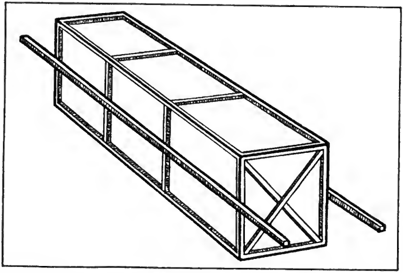

FIGURE 47. – Sketch of field fumigation box. Wooden frame with bituminized paper inside. The bottom is open. Basra, Iraq.

(Courtesy Mrs. Joy Dowson)

covered with strong, bituminized paper (Figure 47). The bottom of the box is open. The paper projects round the bottom edge, so that when the box is in position over the dates, the flap can be weighed down on the ground with earth to reduce the escape of fumigant. One of the longitudinal members of the box frame on each side projects at each end to form handles. A box to cover 4 tons of dates measures 3.5 × 2 × 2 meters and does not weigh more than 80 kilograms. Four men, one at each handle, easily raise the box shoulder-high and then lower it over the stack of cases. It has, however, to be recognized that unless the material is gastight, it will be difficult to maintain the necessary concentration of the fumigant. Impregnated canvas is a better material than bituminized paper but is more expensive.

Mud chambers

Winter (1959) advocates the use of mud-built fumigation chambers in the field. They have much to commend them in regions where clay is at hand and where house construction in mud is practiced. They can be made reasonably airtight if well plastered with mud from time to

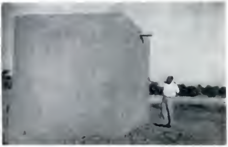

FIGURE 48. – Mud fumigation chamber. Bouga. Sudan.

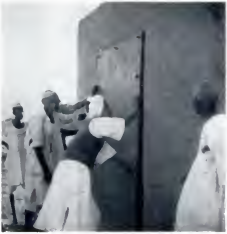

FIGURE 49. – Fastening door to mud fumigation chamber. Bouga. Sudan.

time, inside and out, but they suffer from the disadvantage of difficulties in sealing the door and of danger if, after the door is opened, enough time is not allowed for the dispersal of the fumigant before the entry of the laborers to remove the dates (Figures 48 and 49).

FUMIGANT

Field fumigation differs from packing house fumigation in being practiced by farm laborers and other persons without the supervision of skilled technicians conversant with the dangers in the use of powerful fumigants. Therefore, for field use only, a fumigant that is comparatively harmless to human beings is recommended, even though it may be less efficient than others. Such a fumigant is a mixture of three parts of ethylene dichloride and one part of carbon tetrachloride, called ECM or chlorasol. It has been used successfully for many years by a large date company in Basra, Iraq, by unskilled people, and without casualties.

Kapsiotis (1956 and 1958) states that this fumigant does not destroy insect eggs, so that the dates may need more than one fumigation before packing, in order to kill the young larvae that hatch from the eggs unkilled by the first fumigation. Both Kapsiotis and Winter (1958 and 1959) therefore recommend methyl bromide for field fumigation. They state that the dispersion and dilution of this gas in the open air is so rapid, that there is no danger of poisoning if precautions are taken. Kapsiotis adds that chlorasol is five times as expensive as methyl bromide. Winter, however, points out that it is necessary to recognize that the use of methyl bromide and many other insecticides under field conditions always presents danger, and that they should therefore be handled with the utmost care and only by trained men under responsible supervision.

For a fuller discussion of fumigants and fumigation, see the section on " Fumigation. "

Field packing

Most of the world's dates are packed in the field and only a small part in packing houses. It is likely that field packing (Figure 50) will continue to be important in the date industry because, although packing house packing is cleaner and in several ways better, it is more expensive. Field packing is largely for the cultivator and his family, but dates packed in the field also enter widely into commerce, such as that practiced in Basra for the trade in low-quality dates.

The containers used in field packing, with two exceptions, are made by the cultivator and his family, or by his neighbors in the village, from local materials. The exceptions are the modern 18-liter kerosene or petrol tin and the 200-liter oil drum. The earthenware jar is also in some places an exception because it must be brought from a distance if there is no suitable clay.

Dry dates are packed in sacks (Figure 51), but the cultivator will press soft ones into a compact mass in a suitable basket or other container; such a compact mass keeps reasonably well. The materials available to the cultivator for containers suitable for these purposes are the leaflets

FIGURE 50. – The packers start their job young. Iran.

of palms, the skins of sheep and goats, earthenware jars and, by stretching the meaning of container somewhat, strings may be included.

When a container is small, for example, a goatskin, the dates are rammed down tightly with the clenched fist, but for bigger containers, in the absence of mechanical presses, the feet are used.

It is, nevertheless, hardly to be doubted that the packing house with its cleaner methods, despite their cost, will increase its production at the expense of the field pack.

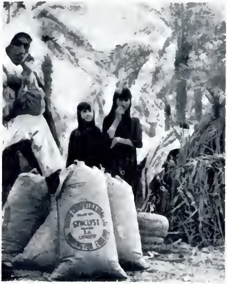

FIGURE 51. – Dry dates (Zahdi) in paper-lined sacks. A basket of Istaamraan dates in the background. Khorramshahr, Iran.

BASKETS

Basket making is one of the oldest crafts and the leaflets of the date palm lend themselves readily to it, so that it may be supposed that they have been used for date baskets from remote times. What appears to be the earliest mention in English of baskets of dates, as opposed to mention of dates only, occurred in March 1631. It is in a letter to the East India Company from Richard Barry, who mentions loading " frayles " of dates in the Persian Gulf. It is, however, to be expected that a study of early Arabic literature, or of the Sumerian clay tablets, would bring to light very much earlier references. The " frayle " is the *farsala*, the large date basket of the Gulf of Oman and the Hadhramaut coast.

Baskets to be used as date containers are most commonly made from the leaflets of the date palm, but on the coast of Libya, where esparto grass (*Stipa tenacissima* L.) is common, this is used also. It makes a stronger but more costly basket. In the Sudan, the leaflets of the duum palm (*Hyphaene thebaica* Mart.) are also used but those of the date palm are preferred. In Makran (Iran and West Pakistan), baskets made from the leaflets of the date palm are used but those made from the Daaz or Mazari, the dwalf palm (*Nannorrhops ritchieana* H. Wendl.), where it is available, are preferred. *Nannorrhops* is Willis' spelling (1951); Blatter (1926) spells it *Nannorhops* and the Encyclopaedia Britannica (1929) spells it *Nanorrhops*.

The younger the leaflet the greater is its pliability; but it is also narrower and shorter. Thus the strip of matting into which the young leaflet is made is narrow, and the time required to make a given area of strip is longer than it is with older leaflets. Therefore, and in order not to damage the palm, it is generally the outer fronds that are cut to provide the leaflets for basket making. Leaflets that are beginning to turn brown, however, should not be used because they are too brittle.

The leaflets are split in two longitudinally and plaited together to form a long strip 8 centimeters or so wide. The strip is then coiled on itself in a spiral and the edges sewn together with string made from leaflets rubbed between the hands, or cut off the well-beaten and then split main stem of the date fruit bunch. When the strip has been wound round in a spiral flat on the ground to make the bottom of the basket, the winding continues but the strip is now set on edge, so that the side of the basket is made. The top of the basket is usually narrower than the bottom.

In Iraq, the dates do not fill the basket, so that the upper part of the

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side can be bent over and held in place with string threaded through the matting and drawn tight to close the basket completely. In Libya, the top is left open. Some protection is afforded to the dates by the practice of stacking the baskets, so that those of the second, fourth, and sixth layers, etc., are upside down, while those of the first, third, and fifth layers are the right way up. In this way, the uncovered surfaces stick to each other and less surface is exposed to air and insects, but for transport and general handling, the Iraqi method is cleaner.

For the dates to be packed in baskets in the experimental date-packing house in Tripoli, Libya, in 1954, special baskets (Figure 52) were made on a light, metal form, so that all the baskets were of exactly the same capacity (100 kilograms). For these, flat, circular mat covers were made and sewn into the mouth of the basket. The uniformity of size was necessary to allow for machine pressing (Figure 53) of the dates, which were destined for school feeding. The covers kept the dates cleaner than those in baskets without covers.

SKINS

Skins which are no longer serviceable as floats, receptacles for water, milk, sour milk, honey, or as milk churns, are used as containers for soft dates. In the climate of Baghdad, Iraq, where they used to be employed in large numbers, especially for the Khastaawi variety, dates keep in them excellently for a year or more; but Munier (1955), writing of the dates packed in skins in Mauritania, states:

" The conservation of dates in skins is only possible in very dry regions, thus barring exports to territories with a humid climate, such as South Guinea, Ivory Coast... ".

The skins for the Baghdad dates were largely the ones that had become damaged on the rocks, or otherwise on the river journey down from Mosul, during which they were used to support the rafts of poplar logs on which travellers and merchandise travelled until the end of the first quarter of the present century. Road and rail transport have now replaced the raft, so that there is no longer much packing in skins in Baghdad. In its place, there is a considerable retail trade of dates in boxes and cartons supplied by the new date association packing house there.

Skins, however, still maintain much of their importance in those date countries where grazing occupies a large part of the population, namely, Mauritania, Algeria, Chad, Sudan, Saudi Arabia and Makran (West Pakistan).

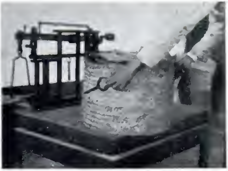

FIGURE 52. – Specially made baskets of uniform size and containing 100 kilograms of dates each were used for the school-feeding program in 1954. Experimental Date-Packing House, Tripoli, Libya.

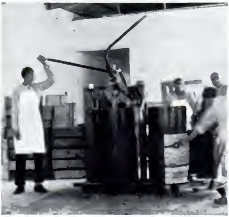

FIGURE 53. – A mechanical press was used to press the dates into the baskets.

JARS

The origin of the potter's art, like that of basket making and of curing skins, must be extremely ancient but, here again, the earliest noted reference in English to dates being preserved in jars is of comparatively recent date. It is that of the anonymous narrator of Vasco da Gama's first voyage (Ley, 1497). He states that some of the crew were entertained by the lord of a part of the Island of S. Jorge, off Mozambique, and given on their departure a jar of bruised dates made into a preserve with cloves and cumin. This was in March 1498.

The jars in which Ali Baba's 40 thieves hid themselves were oil jars, but some of the unglazed and roughly glazed jars (*khaabiya*, plural *kha-*

waabi) used for storing dates in the Fezzan, Libya, are also big enough to hold a man. Such jars may be as much as 1½ meters high and 1 meter in diameter at the widest part. These will be referred to again under the following section, " Field Storage. " The smallest ones extensively used are those of Makran, Iran and West Pakistan; they are only about 20 centimeters high and about 7.5 centimeters wide at the mouth.

Medium-sized jars are used in the United Arab Republic (*ballaas*), the Sudan (*ziir*), and the Punjab (*chatti*), but more for home storage than for sale necessitating transport to market.

The small Punjabi *chatti*, which is of the usual jar shape and which is sometimes sold in the market, is sealed with a piece of cloth to keep out insects, or by an earthenware lid cemented in place by flour paste or mud (Milne, 1918). Elsewhere clay is the usual seal.

The Makrani jar (*humb*) of Iran and West Pakistan looks more like a drainpipe than a jar (Figure 54). The top is a little narrower than the bottom. The bigger ones are for home storage, but the smaller ones are exported and find a ready market in the rest of Baluchistan. and Pakistan.

PACKING METHODS BY REGION

Packing methods grouped by types of container having been reviewed above, there follows below a review of these methods grouped by regions, although all regions where dates are grown are not included.

Mauritania

Dry dates are packed in sacks and soft dates in skins (Munier, 1955).

Chad

In Tibesti, soft dates of the Hadiba, Iliblodom, and Tedersi varieties are usually pitted, made into a paste, and pressed into goatskins (*senugu*), but some are packed in baskets of date palm leaflets, or of leaflets of the duum palm. Dry dates, of the Awosok, Dogolomi, Kolonbuna, Sofor and Tamsa varieties are packed in sacks. These are the dates that serve instead of money as a medium of exchange in barter for millet, wheat and salt (Le Coeur, 1950).

Sahara

The good quality Daglat Nuur, and also much of the dry crop, are sent for packing to the packing houses, but some of the dry dates are

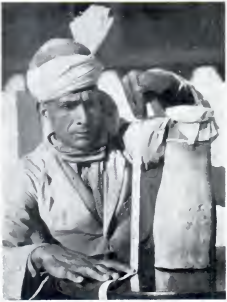

FIGURE 54. – In Makran, Pakistan, considerable use is made of the earthenware jar (*humb*) in which dates in syrup are preserved for home use and for export.

sacked and consumed where they are grown, or sent south, or north to Algeria.

The soft dates, especially the Ghars, are usually packed in skins and the Daglat Beidha and other dry dates are sacked.

Libya

In the Fezzan, most of the dry dates (and they form the greater part of the crop) can hardly be said to be packed at all. The dates are carried in a basket from the palm to a pit in the sand (Figures 55 and 56) and tipped into it. They are then covered with sand, and the storage operation is complete. Taasfirt and Aureig are the commonest dates stored in this manner but dates of all the varieties which will ny off thoroughly on the palm can be found in pits. Those which cannot usually be stored there, because they do not dry well, like Gaugai and Naafuushi, are normally eaten fresh. The intermediate class of soft dates, such as Taaliis and Taaghiyaat, are packed in jars.

On the coast of Tripolitania and in the desert of Darj, dates are packed

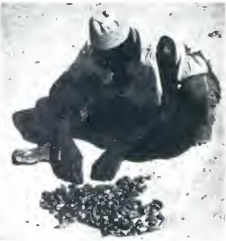

FIGURE 55. – The usual storage place in the Fezzan, Libya, is the sand pit or *matmar*. The sand here has been removed from the top of the dates.

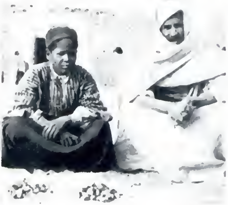

FIGURE 56. – Aukali dates on left, Taasfirt on right, removed from *matmar* (sand store). No live insects. Ubaari, Fezzan, Libya.

in baskets. The Darj basket is called a *hikma*. On the coast of Cyrenaica, the small date crop is almost all eaten fresh and there is practically no packing.

In southern Cyrenaica, most of the date crop is packed in sacks, but jars are used for the softer kinds of dates.

United Arab Republic

The following account of field packing in the Republic is largely based on Brown, 1924, and Brown and Bahgat, 1938.

Dry dates, mostly found in the southern part of the United Arab Republic, are cut from the palm, allowed to dry for two or three days on the bunch, then picked off and spread on wood ashes on the ground. The dates are turned every four or five days for five or six weeks, or even longer, and then mixed with more wood ashes and sacked. Perhaps wood ashes do keep insect pests away. This method is used in the Sudan, where the dates are heaped for several weeks and turned from time to time to discourage termites.

The packing of soft dates is practiced mostly in the center of the United Arab Republic, because in the north nearly all the dates are eaten fresh, and in the south nearly all the dates are dry. For home use, jars are generally used, and for sale, baskets. There are two main date products: *kabiis*, pressed dates with their pits, and *agwa*, pressed, pitted dates (the *ajiin* of Libya). A luxury product which has the skin removed as well as the pit, is also made. To make this, of course, the dates have to be in the *rutab* stage, in which the skin is easily slipped off the flesh. These skinned dates are pressed in jars, but *kabiis* and the ordinary *agwa* are pressed into baskets made of palm leaflets.

A peculiarity of packing in the southern part of the United Arab Republic is that dates are worked into a paste by trampling on a mat (*bursh*) on the ground, to ensure a thorough breaking down of the fiber of the date and the complete exclusion of the air. They receive a second trampling when the paste is put into the basket (*fard*, *zanbiil*, *ganba* or *qafas*). Another Egyptian practice that might well be copied elsewhere is that of inserting the basket into a hole in the ground of such a size as to support it closely all round. The treader is thus able to jump first on one leg and then on the other and to exert considerable pressure without toppling over or bursting the basket.

Sudan

Most of the Sudani dates, already dry when harvested, are packed in packs after some weeks of further drying on the ground in the *shuuna* or garden date-collecting station. Some of the normally dry dates, more particularly of the Gundeila variety, but also of Bintamauda, Kulma and others, are made on a small scale into a so-called soft date. They are cut early, matured in the sun for a week and then in sealed jars (*ziyaar*) about 60 centimeters high, for another ten days. The dates are then emptied out and the culls removed. Good dates are returned to the jars and these are sealed. The dates keep indefinitely but their quality is poor and they remain fibrous. There is also some packing of the softer dates in baskets of date palm and of duum palm leaflets in skins and also in kerosene tins.

Hadhramaut

The Hadhramaut date groves are situated in two climatically sharply distinct zones: the humid coastal zone, and the intensely dry interior valleys. On the coast, therefore, the dates fall from the palm before they have dried into *tamar*, that is, when they are still *rutab* (called *qara*) or, rather, would fall to the ground if they were not caught in the pieces of old sardine net that are wrapped round the ripening date bunches to catch them. The *qara* or *rutab* dates then have to be dried in the sun on the ground in the garden date-collecting station (*dira*) for about 20 days. They are then stamped into baskets in a compact mass which is called *marzuum*. The basket is called *abya* in Asid and Seiyuun, *shataf* in Gheil Umar, *jiraab* in Harshiyaat, *waa* in Waadi Hajar, and *gausara* in some places on the coast. These baskets are longer and shallower than those commonly used in North Africa, northern Arabia, Iraq and Iran.

Inland, the dates dry completely on the palm but, as the bunches are cut while some of the dates are still soft, the whole lot is usually dried for a couple of days on the ground before packing. Most of the crop is packed in jars, some of them very large, like those of the Fezzan, which hold up to 3 *bahaar* (about 400 kilograms) of dates. The Sultan of Seiyuun is said to have 200 to 300 such jars and other dignitaries possess nearly as many. If the crop is heavy and there are not enough jars to hold it all, the remainder is packed in baskets. The dates that are most usually pressed into jars or baskets, that is, those which are not chiefly eaten fresh, are the Jizaaz, Hajari, Madiini and the Mijraaf. A pitted date paste called *siim*, like the *agwa* of the United Arab Republic, is also made.

Muscat

Baskets are the usual containers for dates in Muscat, the longer *farsala* in Dhufaar and the shorter *gausara* in the Baatina. There are two sizes of *gausara*, the smaller of 10 Muscat *mann*, that is, 40 kilograms, and the larger of twice that capacity. Even the shorter *gausara* is still longer than the circular Iraqi basket, the *khasaafa*.

It might have been expected that the coast, where date palms are so abundant, would have supplied all its own packing baskets, but in fact there is a considerable importation of these from the mountain oases, where the palms are more vigorous and where, consequently, the leaflets from which the baskets are made are longer, wider, and stronger.

Boiled dates are packed in baskets and sacks.

Bahrein

The whole crop for commercial purposes is packed in baskets (*jilaal*, singular *jilla*).

Hasa (Saudi Arabia)

Most of the date crop is packed in baskets containing about ¼ *mann*, that is, about 60 kilograms.

A common arrangement for basket making is for one party to provide the leaflets, and another the labor for weaving the leaflets and making up the baskets. The finished baskets are divided equally between the two parties. There is some packing in jars, skins and kerosene tins. Boiled dates (*saluuq*) are generally packed in sacks of wool or jute.

Iraq

Two thirds of Iraq's enormous date crop is packed in the field in baskets (*khasaafa*, *hallaana*, *nuseifi* or *gausara*) made of date palm leaflets, as already described. For months before harvest, the cultivators and their families are engaged in plaiting the narrow strip (*safiif*) out of which the baskets are quickly made.

The baskets hold either 1 *mann*, weighing here 72 kilograms, or one half this quantity, when they are called *nuseifiyaat* (plural of *nuseifi*, from *nusuf* = half). The dates, ¼ of a *mann* at a time, are weighed out usually in a box on an ordinary scale or suspended from a yard-arm balance, or on the pan of a home-made scale made out of rope and a pole, and employing a lump of hard-baked clay as a weight. Two boxes of dates are tipped into a small basket and four into a large one. The tipping is done gently by a man or boy, while a man rams them well down into the basket with his feet. If the dates are dryish, they are sprinkled with water. Good quality dates well packed in proper baskets will last for two or three years if they are protected from insect attack. A small piece of matting is put on the dates, and the top edge of the basket is drawn in tightly over it by means of a string made from fiber of the date bunch midrib. The filled baskets are a little wider at the bottom than at the top, not only because they were so made, but also because the pressure exerted on the dates at the bottom of the basket during filling, and hence on the lower part of the side, is greater than that to which the dates at the top are subjected.

Kerosene tins of 20 kilograms net each are also used, mainly for export to Indonesia. Dry Zahdi dates are packed loose in jute bags of 75 kilograms net each, or in baskets containing 50 kilograms net, and wrapped in sacking. The dry, cooked dates Chibchaab and Bureim are packed in sacks of 100 kilograms net.

Skins are used for packing Khastaawi and some rare varieties for local consumption only.

There is only a little packing in jars, and that is mostly of dates in date syrup. The syrup is called *dibis* in Iraq and *seilaan* in the adjacent part of Iran, *shiira* in the rest of Iran, *asal sahh* in the Muscat Sultanate, *hall* at Makalla (Hadhramaut coast, Aden), *qutaara* at Aden, and *rubb* in Libya.

Iran

The field-packing methods in the main Irani date-growing region, that bordering the Shatt el-Arab river, are similar to those in southern Iraq, of which district the Irani region geographically forms a part.

Pakistan

There are two main date-growing districts in West Pakistan, the valleys of the Indus and its tributaries, and Baluchistan. The Baluchi date palms are in Makran, the southern part of the province, and are mostly in two groups, that of Kech on the Dasht river to the south, and that of Panjgur on the Rakhshan river to the north.

Both Kech and Panjgur have climates that do not permit of the production of first-quality dates; the former is too humid and the latter too cold. Consequently, in neither district do the dates ripen into good, long-keeping *tamar*, and various devices have to be adopted to preserve them. Of these, the most characteristic of the region is the immersion of the dates in the *khalaal* and *rutab* stages in syrup, extracted from other *rutab* dates. In Kech, the dates from which the syrup is expressed are of the Gonzali, Humbi, Kaleruk and Rogini varieties, while in Panjgur, it is the Kahruba variety that is used. The dates which in Kech are commonly preserved in syrup are the Begamjangi, Chapshuk, Haleni, Kaleri and Muzaati (Muzawaati), while in Panjgur, hardly any variety except the Muzaati is used, but almost the whole crop of this variety is disposed of in this way. The syrup is expressed by the pressure of palm logs laid over baskets of dates piled on a plastered, sloped platform in the garden.

Chuptagen kulont (see "Field Ripening and Curing," p. 84) and *tallo* are Makrani dates in the late *khalaal* stage preserved in syrup in pitcher-shaped jars, but they are for home use. For the considerable trade with the rest of Pakistan in dates preserved in drainpipe jars, dates in the *rutab* stage are normally used, though Haleni *khalaal* sun-ripened on the ground for a week are also immersed in syrup and sold.

These drainpipe-shaped containers are of two sizes: the smaller are about 7 centimeters in diameter at the mouth, about 10 centimeters in diameter at the belly, and approximately 21 centimeters high; the corresponding dimensions of the larger containers are about 12, 14 and 30 centimeters, and they hold about 2 kilograms of dates and syrup. The syrup thickens on standing, possibly by evaporation through the porous wall of the unglazed earthenware jar, and forms a sugary crust at the top. The jar is usually sealed only with paper and string. The dates keep practically indefinitely in the syrup, and insects are excluded, though ants may collect at the mouth.

The main crop is packed in skins, *hinzak*, holding approximately 35 kilograms, and in baskets. In Panjgur, the dates, without being pitted, are stamped into baskets (*pat*) or pressed into the skins, and form a mass known as *danagi*, like the *kabiis* of the United Arab Republic, but the dates do not keep more than about six months. In Kech, the dates are pitted and then stamped on a mat into a paste called *laghati*, like the *agwa* of the United Arab Republic, before being pressed into the baskets which hold about 11 kilograms each. Packed in this manner, the dates keep longer than they do when packed as *danagi*.

A third and luxury confection is *dastlagash*, which is a paste made from dates of the Haleni and Dandaari varieties in Kech, and in Panjgur from the Muzaati, pressed into skins or small baskets (*garko* in Kech, *pachak* in Panjgur), but which differs from *laghati* in that the skin and cap, as well as the pit, are removed before pressing (Hughes-Buller, 1906).

Boiled dates, the *khalaal matbuukh* of Iraq, called *harag* in Makran and *bhugrian* in the Punjab, are packed in sacks.

Perhaps the simplest "container" for dates that has hitherto been devised is the string on which in Panjgur sun-dried halves of the Muzaati date are threaded, in the same way as Smyrna figs. Pitted Shahaani dates in Fars (Iran) are similarly treated.

In the rest of Pakistan, where the date groves for the most part are not very big, are generally near large centers, and where early rains necessitate harvesting the crop in the late *khalaal* or early *rutab* stages, most of the crop is sold fresh, and there is consequently little field packing. What is packed is first sun dried and then packed in *chattis*, squat jars without handles, made of unglazed earthenware (Milne, 1918).

Khalaal matbuukh, the *bhugrian* of the Punjab, are packed in sacks.

Field storage

As has already been mentioned, the greater part of the world's dates are packed in the field. Similarly, the greater part is stored in the field, the house, the tent, the mat hut or the local merchant's warehouse. The modern refrigerated or fumigated insect-proof store houses only the smaller part of the crop. Consequently, a short survey of the methods of field storage is appropriate. The practice of field storage may be expected to continue, so that it is important to know what methods are commendable and to consider how others can be improved.

Home storage will also be reviewed here, because generally there is no distinction between it and field storage, as the cultivator's home is in the date garden or nearby.

In the previous section, " Field Packing, " there have been mentioned baskets, skins, jars, drums and tins. All of these, with the exception of the bigger jars and drums, are portable and between them carry most of the dates in the world's trade, and all of them, of course, serve to store the dates as well as to transport them. The nomad stores his year's supply of dates in baskets or skins, the merchant in baskets stacked in his warehouses. The settled cultivator, however, for his home supply, does not need the container to be portable. He employs for temporary storage the not very satisfactory large, circular bins of matting, as in the United Arab Republic and Mexico, the *bunques* of Lower California (Nixon, 1953), or, for longer storage, the excellent large earthenware jar and rather less excellent mud or plaster bin.

THE BIN

The bin of southern Iraq varies in size, but an ordinary bin is about 3 meters long x 2 meters wide x 2 meters high. It is built of mud and the walls are perhaps 60 centimeters thick at the bottom and half as much at the top. If an existing wall is available, the bin (*madbasa* or *mudibsa*) is set against it. The back wall is made higher than the front, so that the roof slopes to carry off the rain. A bin of the dimensions given above would hold about 12 tons of dates, but some bins hold as much as four times that amount. The floor of the bin is corrugated and covered with plaster of Paris. The channels between the corrugations lead to an outlet through the wall in which a reed is inserted. The reed spout is set over a hole in a kerosene tin, which is sunk in a small pit at the bottom, outer edge of the wall. The date syrup flows out from the dates, usually of the Istaamraan variety, the Sayir of the merchants, by the pressure of the other dates above them and not, as in the United Arab Republic, Dashtistan, Ininab (Iran) and Makran (West Pakistan), by additional pressure provided by weights.

The Iraqi trade term " Sayir " is the Arabic word meaning remainder. Formerly, trade quotations were for Hallaawi, Khadhraawi and Sayir, that is, the remainder or the other varieties. As the Istaamraan was the commonest of these other varieties, the foreign trader called this variety Sayir, and the name has remained in the export trade. The cultivator, however, would not ordinarily call an Istaamraan palm a Sayir, unless he is speaking to a foreigner or to someone who is uninformed about dates.

The syrup that exudes is thicker than that made in the Baghdad factory by heating and soaking the dates, and the subsequent concentration of the solution, and despite the presence in it of an occasional wasp, the local people prefer it to the more refined product.

The dates usually do not remain for more than a month or two in the *madaabis* (plural of *madbasa*), that is, until the grower can find a buyer, either a merchant in the town or the captain of a sailing boat bound for ports south. The surface of the dates is protected by reed mats, but there is, of course, insect infestation there (Figures 57, 58 and 59). If, however, the whole bulk of the dates is taken into consideration, the amount of insect damage is slight. If the dates are to remain over the winter in the *madaabis*, the mat roof is mud plastered, and though a good seal round the edges is not made, insect damage is still not serious.

A somewhat better bin than the Basra one is used in the Oued Souf (Sahara), because it is made of plaster of Paris instead of mud. The bin is sunk in the sand and is used for the drier dates; but for the Ghars and other softer varieties, from which the syrup is to be extracted, the circular, plaster bins (*khaabiya*, plural *khawaabi*) are set on the sand floor of the house storeroom. The jar to receive the syrup is set in a hole in the sand beside it. Mats cover the dates, but on top of them and below

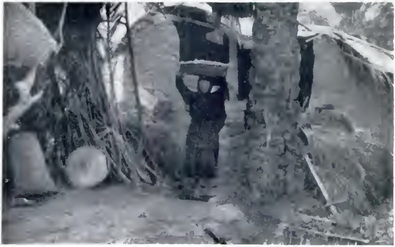

FIGURE 57. – A field storeroom for Zahdi near Baghdad, Iraq.

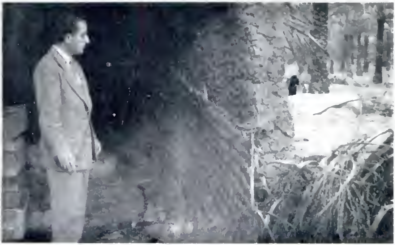

FIGURE 58. – Nearer view of the same store. It is open to the air and the mat roof does not keep out the rain. In all respects, a poor storehouse for dates. Baghdad, Iraq.

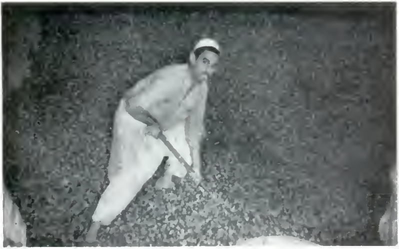

FIGURE 59. – Inside the same store. The dates are in a nearly solid mass and to that extent the lower level is protected from insect attack, but the surface is, of course, exposed. Baghdad, Iraq.

the mat, a flat, circular, plaster slab is placed, on which a man stands while digging out the dates all round it with a horn from a goat or gazelle, or other implement, for the daily requirements (Cauvet, 1914).

A still better bin is the circular one used in the Sudan, because the roof is plastered with mud and makes a good join with the mud sides. When dates are needed from this bin (*quseiba*, plural *qusaiyib*), a hole is made in the wall near the bottom. The dates are extracted and the hole is plugged with fresh mud, while a small bunch of thorns from the *sanat* tree (*Acacia arabica* Willd.) is tied over it, to prevent the dogs from scratching it away and getting at the dates.

A mud bin for storing dates, the *sama*, is also used in the United Arab Republic.

THE JAR

Better than the bins for storing dates are the unglazed, earthenware jars that are used to some extent in nearly all the date-growing districts of the Old World. They are better because the fired clay of which they are made does not crumble and mix with the dates. These jars do not crack, unless broken, as do the ordinary mud walls, thus allowing the entry of air and insects. The mouth, being small in relation to the capacity of the jar, can be comparatively easily sealed to exclude insects.

The very big jars of the Fezzan in Libya deserve mention because they are usually built into a mud bench along one or more of the walls of the house storeroom. The jars are set up in a row against the wall, almost touching each other at their widest parts. The intervening space is built up with mud, so that a bench is formed 1 meter, or 1.5 meters high, and a little wider than the stoutest jar. The mouths of the jars appear as a line of large, circular holes in the top of the bench. Such large jars hold up to about 400 kilograms each of tightly pressed dates.

To keep insects from attacking the smooth, paste-like surface of the dates at the top of the jar, a little olive oil is usually poured on it. When the oil dries up it is renewed. Good dates, well pressed into jars in this manner and preserved from insect attack, will keep in sound condition for several years. The jars remain *in situ* for many generations.

Smaller jars are used in Iraq and elsewhere for dates which are preserved in date syrup.

There used to be a trade in date jars from places which had good pottery clay, for example, the Island of Jarba (Djerba), to places which had none or where the potters' craft was not followed, such as the Fezzan in Libya. This trade, however, is dwindling with the increase in the availability and use of large, lubricating oil drums. The metal drum has the great advantage of being unbreakable but has also the considerable disadvantage of spoiling the damp date which comes into close and prolonged contact with the metal. Unlike the unglazed, earthenware jars, the metal drum does not allow the moisture of the dates to evaporate. Some people have used paper liners with partial success. Probably polythene bag liners, similar to those used in the United States for packing ground dates in small metal canisters would be successful, but they do not appear to have been tried. The reason may be that they might be torn during the stamping down of the dates into a solid mass.

STORAGE OF PRESSED DATES

In all the methods of field storage mentioned above, the essence of each has been the compression of the dates. This has various results. It converts the loose dates with more or less dry skins to a nearly homogeneous, sticky mass, unattractive to beetle pests, which prefer a dryish date. The mass is also unattractive to the female moth pests, which like a dry surface to sit on when laying their eggs. It also largely excludes the air, and hence also the water vapor in the air, so that the dates neither dry out so much in a dry climate nor absorb so much moisture in a wet one, as they would if they were loose.

Whether pressure, apart from reducing the area of the dates exposed to air, actually improves their food value and keeping quality, does not appear to have been studied. It is possible that it does, owing to the breaking of the cell walls and the liberation of their contents.

SAND PITS

There remains to be described another field storage method, the success of which is due to a different cause or causes. It is that used in the Fezzan of storing loose dates in pits in the sand. The *matmar* or hole is scooped out of the sand, the loose, dry dates thrown in, and then sand is shovelled over them. Most holes are rather less than a meter in diameter and in depth. The sand on top of the dates is from 20 to 30 centimeters deep. A communal collection of pits is called an *ugla.* In these pits, the hard, dry dates are said to keep satisfactorily for two or three years. At Gatruun, in the extreme south of Libya, dates in pits were said in May 1959 to be still in good condition, although they were from the 1956 crop.

The statement that insect pests are never found in the *matamiir* (plural of *matmar*) has been queried. Dowson examined many dates from numerous pits in various places in the Fezzan and, although insect damage is usually evident, he has never found a live insect in them nor bred any out of those he jarred for observation. Martin, during his extended stay in Libya, obtained the same result. The signs of insect damage, frass, cocoons and eaten dates, it must be presumed, were evidence of insect activity before storage, when the dates were lying about on the ground in the gardens.

It would be interesting and useful to know why live insects are not found in the *matamiir.* Some fruits generate carbon dioxide on storage; but the Fezzani dates are so dry that it would appear unlikely that there would be sufficient biochemical activity in them to generate enough of that gas to kill invading insects. Another reason might be that the pits are too hot for the insects; but no records of their temperatures appear

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to have been made, and temperature decreases rapidly from the surface of the sand downward. Another possibility is that the relative humidity in the pit might be too low for insect life. Yet one might suppose it could hardly be less than that at the surface of the sand where, in the palm gardens, insects invade any windfall. There must, however, be quite a difference between the temperature and humidity of the sand under the palms and of the sand outside the gardens in the shadeless desert, where the pits are invariably housed.

Until experiments are made, the matter must rest with that other unsolved entomological problem of the Fezzan, namely, why caravans which leave Tripoli on a spring day, with every cameleer scratching his flea bites every few moments, should be quite free of fleas by the time they arrive in the Fezzan.

Rats do not attack the dates in the sand, which is so loose that it smothers them if they try to burrow. No store could be cheaper. Unfortunately, despite these desirable qualities, the sand pit suffers from a disadvantage that makes dates stored in it almost impossible for a modern packing house to use: the sand enters the date through the hole at the base, which is made when it is plucked from the bunch and leaves its perianth or cap attached to the stalk. The sand also gets under the skin if it is cracked, adheres to the sticky flesh, and is then difficult or impossible to remove, although sand adhering to the outside of the shiny skin can be readily washed or brushed off.

Open sheds

Thoroughly bad stores are those frequently found on the Euphrates and round Baghdad, which are nothing more than huts into which Zahdi dates are tipped in heaps to be out of the rain while awaiting a buyer. Infestation is heavy.

Shade cloth

For dates lying in the gardens awaiting sale, it is useful to cover the boxes, baskets or heaps of dates with shade cloth to prevent egg laying by moths. The cloth is cheap, and if carefully handled, can be used for several seasons. Reed mats are not so good, because the moths can get through the meshes if the weave is loose, or under the mat which, being stiff, does not cover the dates closely.

Field transport

Under this heading are considered the transport of dates from the palm to the collecting station in the garden or house, and from the garden or house to market or packing house (Figure 60).

GARDEN TRANSPORT

A date garden usually has a clearing conveniently near a road, track or waterway, and generally shaded by a mango, East Indian walnut, jujube, tamarind, mulberry, bead or other good shade tree. Big gardens may have more than one such clearing. In this shady, open space called *jaukhaan* in Iraq, the dates are heaped as harvested. To it the dates are conveyed in small baskets called *zanbiil*, carried on the heads of the women, girls and small boys, and in bigger, soft baskets called *jilaal* (singular, *jilla*), or in rigid baskets made of the midribs of date fronds, called *rukuuk* (singular, *rukk*), borne on the backs of the men and youths. The porters help support the weight of the last by means of a thong of plaited matting over the forehead. In places where garden boxes, that is, lug boxes are used, or where export boxes are used as lug boxes, they are carried on the head.

In places where the cultivator's house is not in the garden and where the grading and packing takes place in the house, as, for example, in the Hadhramaut, in Mexico, and also in other places, the dates are carried from the gardens to the cultivators' homes by camel or donkey (Figure 61). The dates may still be on the bunches or they may be loose. They are tipped onto a sacking mat, the corners of which are then tied together, and two such mats, one on either side, are then loaded onto the pack animal.

Improvements on these more primitive methods of garden transport are the truck of California, the punt on the irrigation channels of Basra, and the Decauville railway in one garden in Basra and in a few gardens in the Daglat Nuur districts of North Africa. All these conveyances take the dates in wooden boxes. In the Daglat Nuur districts of Africa and of the United States, a shallower box is used than elsewhere, because the dates of this variety and of the Aliig are normally harvested at an earlier stage than those of other varieties, and are therefore softer and do not withstand crushing.

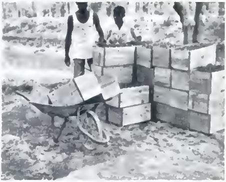

FIGURE 60. – Garden (and packing) boxes for transport of dates from palms to packing house on bank of creek. Khorramshahr, Iran.

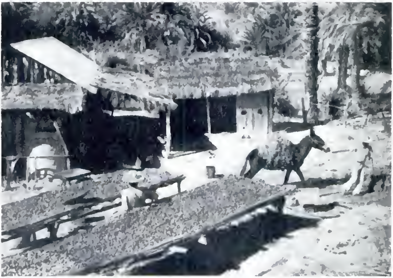

FIGURE 61. – Transport by donkey in gardens. Baja California, Mexico.

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TRANSPORT TO MARKET OR PACKING HOUSE

The wooden box (Figures 62 and 63) is the best container for dates being carried from the garden to the packing house. The lug or garden box, of stout construction, without lid, and with hand holes in the ends, is normal in the fruit trade and is used for dates in the United States. In Libya also, in order to have the coastal, sun-dried Bikraari pitted halves brought to the government packing house in as clean and unsquashed a condition as possible, similar lug boxes for transport from the market were used, but the projected extension of the system to the gardens was not effected, because the packing house switched its demands from coastal dates to the desert variety.

Lug boxes, which are also the export cases, are used in Algeria and in Tunisia for the transport of the Daglat Nuur and Aliig from the gardens to the local packing houses and also to the packers in Marseilles and in Italy.

Similarly in Basra, the export cases are used also as garden boxes. Kapsiotis (1958) considers it undesirable that the one box should be used for both purposes, and for the modern export of dates in small, cellophane-wrapped packs, this is so. For the still considerable trade in tightly pressed dates in bulk cases, it would not seem to matter much if the export case has also collected dates from the gardens because, during pressing and during the voyage to Europe, America, Oceania or South Africa, the date syrup from the packed dates in any event exudes and stains the box. Moreover, using the same box for the two purposes cuts the overhead on each operation by half.

Fibreboard cases with a capacity of 15 kilograms of dry dates each are now being used for the government date-packing house in Libya because, as mentioned above, the packers now buy Fezzani dates instead of the coastal Bikraari. The reason for the change is that, on the one hand, it has proved impossible in the packing house to remove all the sand from the sun-dried, pitted halves by washing, while on the other hand, schoolchildren in the towns, for whose school breakfasts the dates are destined, have become fastidious in respect of them. In the Fezzan, the dates dry completely on the palm; they are not pitted and, if care is taken to grade out those with cracked skins and those without caps (perianths), a sandless date is obtained with very little cleaning. The date groves, however, are 1,000 kilometers distant over bad roads, and the trucks which go down are loaded with goods that pay a high freight. On the other hand, the trucks ordinarily return empty, so that they will carry dates at a low freight. A container which weighs little and which when empty occupies little space, is therefore needed for sending down from Tripoli to the Fezzan. The flat-folding, fibreboard case has, therefore, been adopted; but it has the disadvantage of becoming easily damaged when not tightly filled and well sealed. Nevertheless, 1,000 tons of dates were brought up from the Fezzan to Tripoli during the 1959 season in cases of this kind. Their use certainly keeps the dates in much better condition than that of the dates that used to be merely loaded into lorries without any containers at all.

The punts of Basra have already been mentioned, but on the Nile also, the local craft are used to carry the dry dates of Upper Egypt downstream to market. Most are heaped loose in the boat like so much gravel, but dates of the Gundeila variety are almost always sacked (Brown,

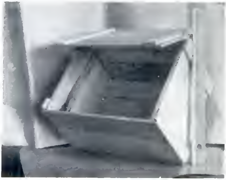

Figure 62. – Box locally made of wood from boxes in which soap, cans of food, etc., have been imported. It was designed to hold 36 date blocks of 1 kilogram each, but now, as the coastal Bikraari block is no longer made, it is used for 36 half-kilogram bags of loose, desert dates. Government Date-Packing House, Tripoli, Libya.

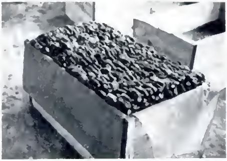

Figure 63. – Completed box, lined with kraft paper before the final pressing. Khorramshahr, Iran.

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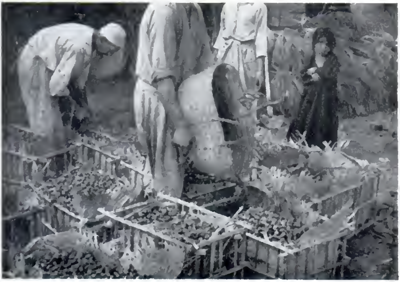

FIGURE 64. – Crates of date palm frond midribs for the transport of dates, more especially in fresh (*khalaal*) stage. United Arab Republic.

1924). The Daglat Nuur and Aliig varieties from the Sahara and Tunisia, which go mostly to France and Italy for packing, are carried, of course, by ship across the Mediterranean.

The train carries the Euphrates Zahdi to the Baghdad packing house, and also the Daglat Nuur and the Aliig to the North African ports; but everywhere the truck is supplanting the train for this class of business. Trucks are even generally preferred for the long haul from the port of Naples to the packers in Genoa, Savona and Albenga. From the garden to the local packing houses in the Sahara and Tunisia, the donkey cart, nowadays provided with rubber tires, is much employed.

It is not necessary here to describe the many kinds of baskets, panniers and sacks used for taking dates to market, but one ingenious device used in Muscat may be mentioned. This is the *mishaan*, a circular cylinder about 30 centimeters long and approximately 15 centimeters in diameter, made of pieces of palm frond midribs, tied together with palm fiber twine. One end of the cylinder is plugged with palm fiber, the cylinder is filled with dates in the *khalaal* (yellow) or *rutab* (soft) stage, and the open end of the cylinder is then plugged with more fiber (*liif*). About 20 such cylinders, each holding about 3 kilograms of dates, are then packed in a long, wide, squat basket of woven palm leaflets (*khuus*) known as a *marhala.* Two of these is a donkey load. The dates arrive in the market at Matra (Muscat) in these containers in excellent condition after their three or four days' journey down from the mountains.

A suitable crate, more especially used to transport dates in the fresh (*khalaal*) stage, is shown in Figure 64.

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4. PREPROCESSING

Preliminary packing-house operations

Date packing-house operations are discussed in the following pages. Preliminary operations are those which come before processing, where this is practiced before packing, or before packing when this precedes processing, or where there is no processing.

RECEIPT OF DATES

Ramp

Dates are generally received at the packing house in boxes delivered by truck, so that the packing house should have an unloading ramp of a convenient height (Figure 65). Since it is here that the first inspection for quality is made, the ramp should allow sufficient room where the boxes may be emptied on trays on the ground. If the dates are on the borderline of what is acceptable, many boxes may have to be tipped out onto trays and, as the refilling of a box from a tray is slower than emptying the box onto the tray, it may be that several trays of dates will be lying on the platform at the same time.

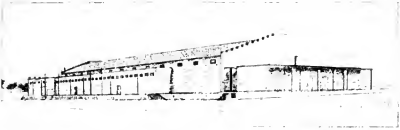

FIGURE 65. - The Baghdad Date-Packing House, with loading and unloading ramp of a convenient height.

(Courtesy Mrs. Joy Dowson)

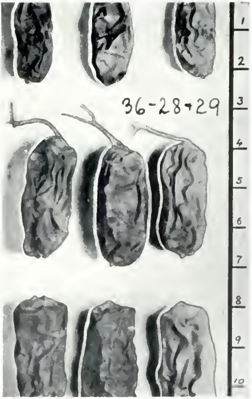

FIGURE 66. – *Hashaf* (shrivelled) dates, the spikelet of which has been partly torn from the main axis of the bunch. Basra, Iraq.

Inspection

The receiver of the dates needs to know his grades of dates well, to be tactful, firm and honest. The quality of the packing house output depends largely upon him.

Even an experienced handler of dates finds it useful, every now and then, to take about 100 specimens at random from various places in a box and then to sort them quickly into grades, e. g., shrivelled (*hashaf*) (Figure 66) infested (*musauwas*), small, dry, fair and good, or whatever the grades might be for the particular district, variety and season concerned, and not to rely solely on general inspection.

Sampling machine

In California, a sampling device is used (Figure 67). This is a device whereby a shaker hopper delivers dates down an inclined slope with a slot in it one tenth its width. One tenth of the dates fall through the slot into a container placed below. These are then graded by hand. If one box in every 10 or 20, according to the size of the consignment, is passed over the sampler, a fair sample is obtained, the analysis of which does not require much time.

A portable sampling device has also been in use for some years in California. Dates are run through and thoroughly mixed by gravity. About one tenth of the dates are separated and this amount is run again, until a 50-ounce sample is obtained. When dates are delivered at the packing house, a number of lugs or boxes (the square root of the total number) is picked at random and set aside for sampling.

Trucks

Clamp trucks (Figures 68 and 69) are convenient for transporting the boxes from the truck to the scale and for most packing house handling. One man can pick up a stack of seven lug boxes in one movement without the use of a pallet and without having to manhandle each box, as he would have to do were he to use an ordinary porter's truck or a three- or four-wheeled one.

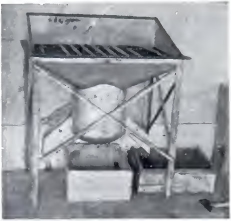

Figure 67. – Date-sampling machine. California, United States.

Scales

The truck takes the lug boxes of dates to the platform scale, which should be sunk so that the truck may be wheeled onto it without difficulty. The truck and the boxes can all be weighed together and the combined tare subtracted from the total. A quick-settling scale with a clear dial is desirable.

A simpler way of weighing dates is for the loaded truck to pass over a weigh bridge provided with a quick-settling balance and a device that stamps the weight on a ticket, and then to pass over it again after unloading to be reweighed. A weigh bridge, however, is expensive, and only a packing house with a large turnover of dates and where labor costs are high could afford one.

Receipts

Receipt vouchers should be given to the supplier for each consignment of dates delivered at the packing house. As the containers are usually returnable and stand either on the supplier's or on the receiver's charge, the number of containers received should be stated on the voucher, as well as the gross and net weight of the dates,

Receipt vouchers should be in a book. Fifty vouchers in one book is a convenient number. Each receipt should be in quintuplicate, so that there is one copy for the supplier and four copies for the receiver, who would file them numerically in four series, which would normally also be chronological, by name of supplier, variety of date and lug box. The five copies of the voucher, including the original, should be of different colors to simplify sorting and to prevent errors. Each of the four series retained by the receiver would be filed in a separate looseleaf binder of the appropriate color, so that, provided a sheet for cumulative totals is kept in each binder or in each section of each binder and held up to date, the receiver could tell at a glance at a given moment the total amount of dates received, the total amount of each variety received, the total amount received from each client, and the total amount of lug boxes received.

The binder listing the varieties would be divided into sections, one for each variety. Totals for each variety and also for all varieties together should be made daily. Similarly, the binder containing names of suppliers would be divided alphabetically into sections, one for each supplier.

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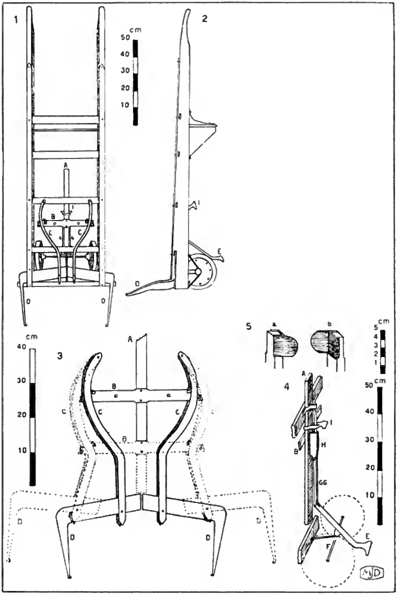

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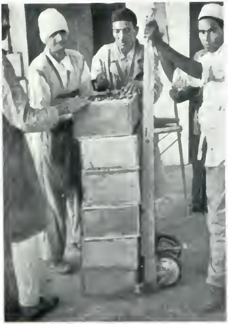

FIGURE 69. – Clamp truck in operation. On arrival, the dates are inspected for quality. Those accepted are stacked seven high and taken by clamp truck to the scales. Tripoli, Libya.

FIGURE 68 (*left*). – Construction of a clamp truck.

1. Front view. 2. Side view. 3. Detail of clamp: curved arms C and C are formed of double metal bars with space between which bar B slides. Bar B is attached to bar A, so that by moving bar A up or down, bar B slides up or down between double arms C and C, altering the position of arms C and C, because they are curved. Claws D and D, which are attached to arms C and C, are thereby moved inward or outward. 4. Detail of pedals which move bar A. Bar A is moved upward by pressing pedal E, which pivots on wheel axle F and pushes up bar A, to which it is connected by GG and H. GG are movable joints, being attached to E and H by split pins. Bar A is moved downward by pressing pedal I, which is attached to bar A. 5. Claw tips, with blade-like projections which slip under date box when claws are moved inward and ensure firm grip. Seen from (*a*) beneath (*b*) above.

(Courtesy Mrs. Joy Dowson)

Whatever filing is adopted, it is important that cumulative totals are made up and recorded daily, because a packer does not want to receive more dates of a particular variety than the quantity for which he has or expects to have orders. It is useful to hang in the office a large-scale graph of daily receipts of dates by varieties and of total daily receipts. This should be recorded each day from the vouchers.

Other classifications could be made, but in practice the total number of copies of a voucher is limited to the clear copies that can be made at one time with a Biro and carbons. In quintuplicate and on thin paper all should be legible. Voucher forms with the copying material incorporated in their undersurfaces are more expensive than plain ones, but the additional expense may be considered justified by the clearer copy obtained and by the time saved.

If the supplier returns with empty lug boxes after delivering his dates, he should be required to sign a consignment voucher for the number taken. Consignment vouchers are also in quintuplicate, but to prevent confusion, their colors should be different from those used for receipts. Instead of a separate series for variety of date, it is generally preferable to have a series for type of pack.

WASHING AND REPAIR OF LUG BOXES

If the lug boxes are dirty after emptying, they should be washed, brushed and scraped before being returned to growers. They may be washed in the sea, as at Tripoli, in the river as at Basra, or with water under pressure from a hose. It is important to wash out moth pupae from the cracks in the boxes, so that hot water under considerable pressure, say over 1.4 kilograms per square centimeter, is desirable.

Automatic box-washing machines save time but, unless the quantity of boxes to wash is large and the cost of labor high, it may not be profitable to install one (Figures 70 and 71).

When stacking empty boxes, it is advisable to put aside those which are broken for repair.

STRIPPING BUNCHES

Much of the Daglat Nuur crop in Algeria and in Tunisia is brought to the packing house by pack animal, cart or truck, either in baskets or loose. The bunches which are not yet ready for stripping must be allowed to ma-

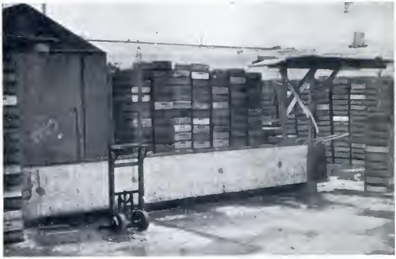

FIGURE 70. – Box washer from side. California, United States.

ture. For this purpose, they are suspended from hooks hung on horizontal poles fixed one above the other in open sheds (Figure 72). The bunches which contain a considerable number of sufficiently matured dates go straight to the strippers, who remove them by hand. The bunches with the less matured dates still attached are then hung on hooks for a few days. As the dates are stripped off the spikelets, they are preliminarily graded into mature, nearly mature, and culls.

STORAGE

Except at the beginning of the season, it is seldom that dates can go straight to the packing floor from the receiving ramp, because for most of the season the daily receipts exceed the daily packing capacity. Therefore, the dates received but which await packing must be stored. As has been noted, some of the Daglat Nuur crop is hung in open sheds to mature. Whether the pyralid moth, *Myelois decolor* Zell., which does so much damage to this variety in the Sahara, attacks the dates in the sheds, is not stated in Wertheimer's paper (1958), but it would seem likely that it does. If this is confirmed, then the open shed should be enclosed by wire gauze.

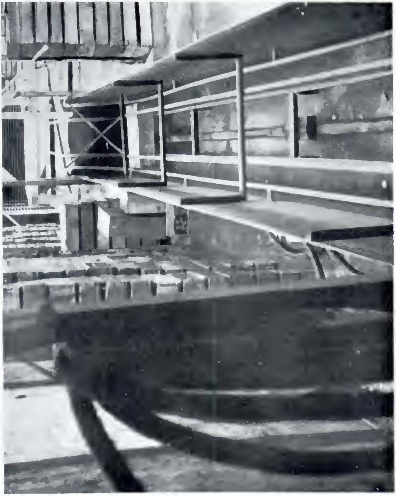

FIGURE 71. – Box washer from end. California, United States.

For dates which have been taken off the bunch, insect-proof storage of some sort is unquestionably desirable to keep out the egg-laying pyralid moths and the beetles. The most satisfactory store is without doubt that which can be fumigated because, as is emphasized in the following section, the shorter the time between the receipt of dates at the packing house and

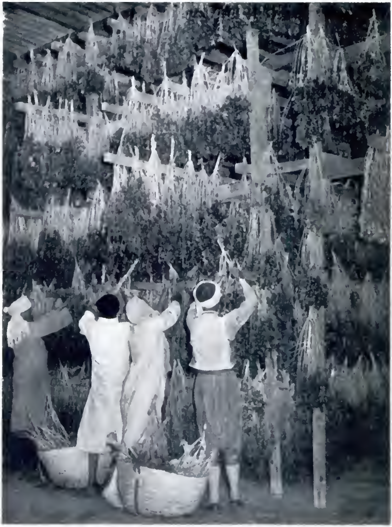

FIGURE 72. – Stripping Daglat Nuur in Tunisian maturation shed from suspended hooks.

(Courtesy Derocles and Cie., Tunis)

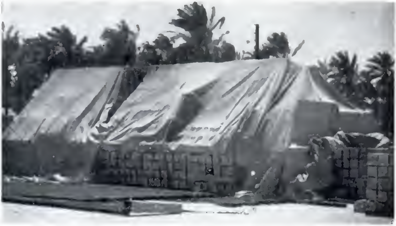

FIGURE 73. – Packed cases of dates awaiting shipment. Storage in the open after fumigation and before shipment should be for as short a time as possible to reduce reinfestation. Basra, Iraq.

fumigation, the less the damage by insect infestation. The only reason justifying delay and storage in a store without fumigation facilities would be that all the fumigation chambers may have been occupied. Even then, however, the use of tarpaulins over the stacks of dates in the open makes fumigation possible. If tarpaulins are not available, the covering of the stack by simple shade cloth is much better than nothing at all (Figure 73).

Fumigation

PRELIMINARY

A short account has already been given of the field fumigation of dates, but as this is comparatively little practiced, while it is a standard procedure in packing houses, the fuller consideration of fumigation has been reserved for the present section.

For the sake of convenience, some other practices designed to rid dates of insects have been considered, although they do not fall within the definition of fumigation.

DEFINITION

Fumigation, as the word is used in the modern dried fruit industry, is the process whereby insects on or in a product are subjected to the influence of a poisonous gas in a closed space in order to kill them. The definition may also be extended to include the killing of insects by the replacement of the oxygen of the air around them by an inert gas.

The dusting and spraying of fruit trees is not fumigation, nor is the application of insecticides around stacked cases of fruit.

OBJECT

The object of fumigation is to kill insects infesting dates in all their stages, egg, larva, pupa, and imago (adult) and mites (*Arachnida*), small insect-like animals allied to the spiders. Even when the infestation is slight, the pests make the date unattractive to the consumer by their presence, by their remains, by their silk and frass, and by the silk and frass of the predators to whose attack they may have been subjected. The presence of only a single larva in a packet of dates may be enough to deter a shopper from buying another of the firm that packed it, or even from buying any more dates. In short, even slight infestation reduces sales, while infestation continued long enough leaves no dates to pack.

In packing house usage, a date is considered to be infested whether it contains a live pest or only evidence of a pest having been in it.

The harvesting of dates takes less time than their packing. The harvest season of any variety usually lasts no longer than two months, and may even be as short as one month, but the packing may continue all the year round. Most dates at their entry into the packing house, therefore, need storing. As simple storage permits the increase of pests, storage must be fumigated or cold, or to start with, at a temperature high enough to kill pests.

ADVANTAGES

Methods other than fumigation for killing insects in dates are immersion in boiling water, exposure to air at a high temperature, and exposure to low temperature.

Small packers sometimes immerse dates for a short while in boiling water before packing, and it is said that insects in the dates are thereby killed; but no results of investigations into the time-temperature relationship necessary to kill all insects in all stages of development appear to have been published. This process, although possibly satisfactory for small quantities of dates of certain kinds, and of specific moisture content, is not suitable for the usual, large-scale, packing-house operation. The difference between the length of time during which the date must remain in boiling water to ensure the killing of larva or egg within or on it, and that at which the skin starts to split and peel off and the date becomes mushy, is probably small, so that, without elaborate machinery, the quantity of dates whose treatment could be supervised by one person may be expected to be small as well.

Dry heat treatment is effective and comparatively simple to apply, but the equipment necessary for treating a large quantity of dates rapidly is expensive and requires much space. The dates, moreover, have to be turned out of the lug boxes and spread one layer thick on trays to ensure uniformity of treatment. The dates, therefore, receive an extra tipping out and consequently suffer additional damage. Furthermore, especially for the Daglat Nuur in its mature stage, heating is harmful, because it darkens the color of the date.

Cold storage has none of the above disadvantages, but it has others. Very low temperatures are needed to kill all stages of date pests quickly. Knapp (1923) reported that *Ephestia* larvae, which had been frozen till they clinked like bits of glass, recovered when the temperature was raised. Dowson (1935) found that the larvae of the Fig Moth (*Ephestia cautella* Walk.) could live for 85 days at a temperature varying between 2° and 6°C. Back and Cotton (1926) report that the Saw-Toothed Grain Beetle (*Oryzaephilus surinamensis* L.) in every stage is killed on exposure to a temperature of -16°C. for one day. It is expensive to maintain such a low temperature in a commercial cold store. It also takes a long time for a low temperature to reach the middle of a box of dates and for the dates in the middle to reach air temperature when the boxes are removed from the store.

Vacuum alone will kill insects, but not quickly. Back and Cotton (1926) report that it took seven hours at an atmospheric pressure of 25 millimeters of mercury, that is, at a 97 percent vacuum, to kill all stages of the Saw-Toothed Grain Beetle. Junaid and Nasir (1956) report that at a pressure of 10 millimeters of mercury, that is, at a 98.7 percent vacuum, maintained for 90 minutes at a temperature of 29°C., no *Ephestia* larvae and no *Oryzaephilus* adults are killed.

Fumigation is preferable to any of the above, because it is quick, cheap, easy to employ, does not necessitate subsequent drying of the dates, does not darken or otherwise damage them, and can be applied to dates both in lug boxes and in packed cases. Vacuum fumigation needs expensive installation but fumigation at atmospheric pressure does not. Fumigation, however, is unnecessary if the packing house is provided with sufficient cold storage and if the dates are to be stored in it for a time long enough to kill the insects. It is also unnecessary if the dates are to receive high heat treatment very shortly after their arrival at the packing house as part of their normal processing, and if they are destined to be kept in an insect-free and insect-proof store very soon after such treatment.

HISTORY

The first time dates were fumigated appears to have been shortly before the first world war in California, but the practice did not become general there until after the war. The fumigants were hydrogen cyanide and carbon disulfide.

By 1924, the larger packing houses in the Coachella Valley had installed vacuum fumigators and were using them with carbon disulfide. The smaller packing houses did not then practice fumigation. Before 1924, carbon tetrachloride had been tried but, as it was a poor killer, it dropped out of use until the early thirties, when it was found to make a satisfactory blanket for ethylene dichloride.

The next country to adopt fumigation for dates was Iraq, where an American date company introduced it in 1926.

By 1928, as a result of an explosion while carbon disulfide was being used, most date packers in California had adopted the use of hydrogen cyanide.

In 1932, Le Goupil discovered the insecticidal value of methyl bromide, but even a year later it was still thought to be unsuitable for the fumigation of food.

The following year (1933), the fumigation of dates was introduced into Algeria by the installation of a vacuum fumigator at Philippeville and of another at Biskra, both using the ethylene oxide-carbon dioxide mixture that had become popular shortly before. Two other vacuum fumigators had already been installed in Algiers and Bougie, but these were primarily for the fumigation of other products (Delassus and Lepigre, 1935).

The installations at Philippeville, Biskra, Algiers and Bougie now practice vacuum fumigation with methyl bromide.

By 1935, the ethylene dichloride-carbon tetrachloride mixture (ECM) or chlorasol was being used in California and, as a result of experiments with it at Basra in the same year by the American company referred to above, its use for field fumigation was introduced there in 1938.

In that year, methyl bromide was still too expensive for commercial use, but by 1940 it had become common in California where, by 1944, it was the most widely used fumigant, and vacuum fumigation was hardly practiced any more.

In December of the following year, 200 cases of methyl bromide poisoning of workers in the date-packing houses of the Coachella Valley were reported, with the result that greater care was subsequently taken in its application.

In 1953, Lindgren and Vincent pointed out that ethylene chlorobromide and ethylene dibromide were more toxic than methyl bromide to certain date pests, but their use has not spread, possibly because methyl bromide kills more quickly.

Libya, on the advice of FAO, introduced the practice of methyl bromide fumigation at atmospheric pressure in its date-packing house at Tripoli in 1955. In Iraq, it was also introduced in the Date Association Packing House in 1953; the Sudan followed in 1959, also on the advice of FAO.

Although methyl bromide is still, after 20 years, the usual fumigant in date-packing houses, yet the United States Department of Agriculture continues to recommend the carbon dichloride-carbon tetrachloride mixture for small lots of dates (Nixon, 1959).

FREQUENCY

The first fumigation should be given in the field immediately the dates are picked. The dates should remain covered until they are received at the packing house. On arrival there, another fumigation should be given, unless the dates are destined for almost immediate heat treatment at a temperature high enough and for a period long enough to kill any pests. After packing, the dates, whether they go quickly to market or to store for a long time, should be fumigated again in case they have become infested during packing. Once properly fumigated in an insect-proof store, dates need no further fumigation; but it is always prudent to examine them from time to time to make sure that the fumigation was indeed adequate and that the store is insect-proof.

Since a date insect, for example, the beetle *Haptoncus luteolus* Ev. may take as little as ten days in which to develop from the egg to the adult stage (Lindgren and Vincent, 1953), dates stored in noninsect-proof places should be fumigated at intervals of the same period. Nixon (1959) states that screens for preventing the passage of date insects should have not less than 14 wires to the centimeter.

Wooden storerooms are often not insect-proof and are in all respects, except cost, inferior to ones properly constructed of masonry or brickwork, so that, generally speaking, wooden stores would need more frequent fumigation than the others. It has always to be borne in mind, when deciding how long to leave a stack of dates between fumigations, that a carton of dates, whether unwrapped or wrapped in cellophane or wax paper, although it will prevent egg laying on the dates by the Fig Moth and its cousins, will not keep out Cucujid and Nitidulid beetles (the Saw-Toothed Grain Beetle and the Corn-Sap Beetle and their cousins).

There appears to be no record of ships being fumigated to kill the date pests that may be brought on board with a cargo of dates. Until recent years, the Persian Gulf dates probably suffered no great damage, since they were either tightly pressed in baskets of 40 or 80 kilograms or in wooden boxes of 33 kilograms. In both containers, the mass of dates was so homogeneous and sticky that the Fig Moth and its cousins found it unsuitable for oviposition, and the Saw-Toothed Grain Beetle and its cousins for penetration.

The trade in dates by sea is of three main kinds: firstly, the very old custom by sailing ship from the Persian Gulf to the coasts of Arabia, East Africa, India and further east; secondly, the steamer trade from Basra, at the head of the Persian Gulf, chiefly to London, Hamburg, New York and Montreal, for which whole ships are chartered; and thirdly, the trans-Mediterranean trade from the ports of Algeria and Tunisia to Marseilles, and the ports of western Italy. For the last trade, ship fumigation is unnecessary because although the dates are loose and not pressed into a block, the voyage takes only a day or two. For the sailing ship trade to oriental and East African ports fumigation is also hardly to be recommended, even though the voyages may last many months, because of the practical difficulties of fumigating a dhow.

However, for the modern steamer trade from the Persian Gulf, which increasingly consists of dates in small packs, fumigation on board might be recommended. It is, however, a matter which needs study for, up to the present, there appears to be no record of the amount of infestation contracted on board, nor of the activity of pests during a voyage. Most of the crop is carried in the late autumn, so that for voyages in the Northern Hemisphere, the temperature is low and insect activity less than it would be in the summer.

There appears to be no reference in the literature to the fumigation of dates in freight or box cars, that is, railway wagons, but if it were practicable, it would certainly be desirable prior to the long journey of perhaps two or three weeks from California to the eastern seaboard.

Fumigants

There are two systems of fumigation: one at atmospheric pressure in a chamber made as airtight (Figures 74 and 75) as can be without elaborate precautions; the other in a chamber from which the air is drawn by means of a vacuum pump and into which the fumigant is sucked on the release of the vacuum (Figures 76, 77 and 78). The use of a vacuum necessitates the employment of a steel cylinder or other chamber strong enough to support a pressure of one atmosphere at every point on its surface. Consequently, for its capacity, such a chamber is expensive and, unless extremely heavy construction is employed, its capacity is small compared with that of an ordinary fumigated store. Its advantage over such a store lies in the rapidity with which small or smallish lots of dates can be fumigated, compared with the time required in a nonvacuum fumigation chamber.

A variety of fumigation without the employment of a vacuum is that whereby the fumigant in liquid form is put into the boxes of dates. The fumigant evaporates and the box acts as a sort of small fumigating chamber.

Fumigants may be solid, liquid or gaseous, but those in the two former states have to vaporize before they can have any effect. An example of a solid fumigant is calcium cyanide, which by the action of the water vapor in the air liberates hydrogen cyanide. A common fumigant, which is liquid at ordinary temperatures is carbon disulfide. Its boiling point is 46°C., but it vaporizes readily at much lower temperatures. A common gas fumigant is methyl bromide, which boils at 4°C.

All fumigants used for dates, except hydrogen cyanide, are heavier than air and consequently, at the beginning of a fumigation, tend to be more concentrated at the bottom of a fumigation chamber than at the top. For practical purposes, especially if circulating fans are installed, it may be

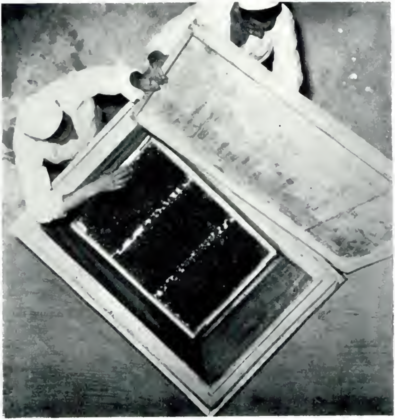

FIGURE 74. – Small quantity of dates on trays for box fumigation with carbon disulfide. Rural packing house, United Arab Republic.

assumed that the concentration of the fumigant is uniform in the whole chamber. Therefore, owing to the influence of diffusion, a few cases in a low stack on the floor would need just as much fumigant as would be needed for the same store completely full of dates. The influence of sorption, however, has to be considered, for the greater the amount of dates in the store, the greater is the surface which can absorb the fumigant, and consequently the greater is the quantity of fumigant needed.

The safe course for the packer to pursue is to find out by experiment which concentration of fumigant is necessary to kill all insects in the store

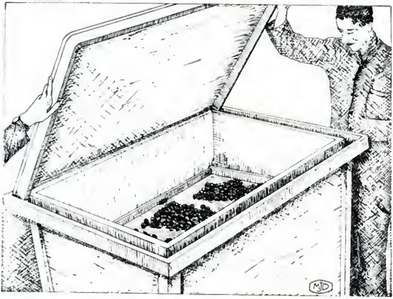

FIGURE 75. – Fumigating box as used in rural packing house in the United Arab Republic.

(Courtesy Mrs. Joy Dowson)

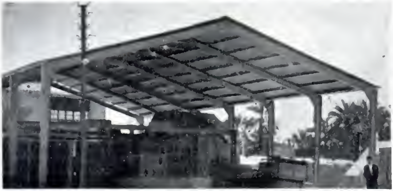

FIGURE 76. – Postwar vacuum fumigating chambers under open shed and packed export cases of dates on trucks awaiting fumigation. Basra, Iraq.

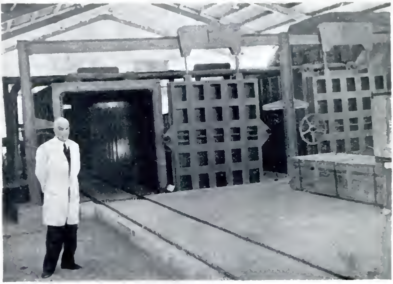

FIGURE 77. – Nearer view of the vacuum fumigation chambers. Basra, Iraq.

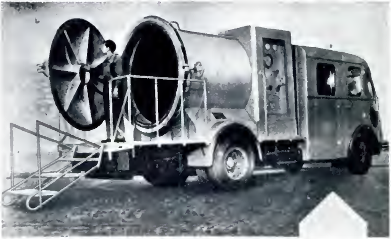

FIGURE 78. – A vacuum fumigation unit, with horizontal cylinder mounted on a truck. Paris, France.

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when it is completely full, and to use the same dose for all subsequent fumigations, whether the store is completely or only partially full. This course would result in some waste of fumigant, but the certainty of a complete kill of insects in all store loads of whatever size is worth what is probably only a small waste of fumigant.

DESIRABLE QUALITIES

The ideal fumigant for dates would kill insects in all stages and kill them quickly, be nontoxic to human beings, not be absorbed by the dates, leave no harmful residue in the dates, not give the dates a bad smell or taste, would be nonexplosive, noninflammable, if not a gas, vaporize readily, diffuse well in the atmosphere, penetrate well into the dates and cost little.

No known fumigant at present combines all these desirable qualities. The date grower or packer has to choose from the available fumigants that which best suits his particular needs. With unskilled labor under minimum supervision, he would sacrifice efficiency for comparative safety, and would probably choose the carbon dichloride-carbon tetrachloride mixture. If the quantity of dates to be fumigated were small, and there were no risk of fire, he would probably choose carbon disulfide, whereas, if the quantity of dates were large, his storerooms airtight and his labor trained and well under control, he would certainly use methyl bromide. It must be added that carbon disulfide is extremely inflammable and explosive in mixtures with air. It should never be used unless the operator and others in the vicinity can be trusted not to smoke.

FACTORS AFFECTING EFFICACY

The higher the concentration of the fumigant in the date fumigation chamber, the quicker is the kill. The longer the time during which the insects are exposed, the larger is the number killed. The higher the temperrature, the quicker is the kill. Concentration, time and temperature are complementary, and an increase in one permits a reduction in the others. Thus W.B. Brown (1954), using methyl bromide at different temperatures, found that 99.9 percent of a variety of insects, some of which attack stored dates, and including the Saw-Toothed Grain Beetle, were killed at the following concentrations:

10°C.	200	mg./hrs.	per	liter
15 "	180	"	"	"
20 "	150	"	"	"
25 "	100	"	"	"

It will be observed that a rise in temperature of 15°C., from 10° to 25°, enables fumigation to be completed in half the time, or with half the amount of fumigant necessary at the lower temperature.

With methyl bromide, in the calculation of the requirements for fumigation, time and quantity – if sorption and seepage are not considered – are interchangeable for moderate and large quantities. However, they are not so at low concentrations of about 2 milligrams per liter or less. These concentrations are too low to kill.

At very low temperatures also, the time × quantity × temperature product is no guide to procedure, for insects become quiescent, respire little, and are resistant to fumigation. Of course, as they are inactive, they do not eat, or do not eat much and do not propagate, so that fumigation is less necessary than it is in hotter weather.

It should be noted that time is to be taken as only the time during which the fumigating gas is at a lethal concentration. Gases are lost through walls and doors that are not completely impervious and they are absorbed by the dates and their containers, so that the degree of concentration of a fumigant in an ordinary fumigation chamber falls progressively. There is no advantage to be gained by continuing fumigation beyond the moment when the concentration of the fumigant falls below its lethal point. For convenience of storing, however, and for the prevention of reinfestation, the dates may well remain in the chamber, if it is not needed for the fumigation of another batch of dates, until they are wanted for packing or dispatching (see p. 170).

A high humidity of the atmosphere and of the dates may reduce the efficacy of a fumigant which, like ethylene oxide, is very soluble in water.

The rate of diffusion of a fumigant influences the length of time of fumigation. The more points there are at which a fumigating gas is released in the chamber, the more quickly it can start its lethal activity. Similarly, the more effective the means adopted for vaporizing a liquid fumigant in the store, the shorter is the period necessary for fumigation.

The shape of a fumigation chamber exercises an influence on the rate of diffusion. Angles and pillars act as baffles and retard it. Probably a cubical chamber, with the fumigant released at the middle of the roof, is the best of such shapes as are ordinarily used, but the size of such a chamber is then limited by the height to which it is practicable to stack the cases of dates. For large quantities, therefore, the height of the chamber has to be less than either of the two other dimensions. However, a large square chamber is usually unsuitable, for the reason that will be given below in the section on "Chambers."

The system of stacking affects the ease of penetration of the fumigant into the boxes and hence the time allowed for fumigation. With a fumigant that penetrates well, it is enough to have slatted floors and to leave a space between the stack and the walls and between the top of the stack and the ceiling. However, the more space there is between the boxes, the more quickly will the fumigation be diffused.

FUMIGANTS

Fumigants that have been commonly used for dates are listed in Table 22, while fumigants which have been tried experimentally against pests of stored dates but which have been little or not used commercially are listed in Table 23.

It will be noted that the boiling points of most of these fumigants are high, which makes them difficult to use commercially, although in the laboratory many gave good results.

SULFUR DIOXIDE

Sulfur dioxide is a cheap and moderately potent insecticide, but it forms sulfurous acid in combination with the water in the dates which, except in minute quantities, is considered harmful in a food product. It is in use in the fruit-packing and processing industry for apricots, figs peaches, etc., but many countries, for goods which have been treated with sulfur dioxide, require the display on the package of a declaration of the treatment received. C.D. Fisher obtained very rapid killing of insects in dried fruit on a continuous belt passing through a tunnel where it was subjected to sulfur dioxide, but this method has not been adopted by the trade.

For the home fumigation of small lots of dates, sulfur dioxide, made by burning sulfur, is useful because it is safe and noninflammable.

TABLE 22. – Fumigants commonly used for dates

Name	Formula	State	Boiling point, °C.
Carbon dioxide	CO_2	Gas	–78
Carbon disulfide	CS_2	Liquid	46
Carbon tetrachloride	CCl_4	Liquid	76
Ethyl formate	$HCOOC_2H_5$	Liquid	54
Ethylene dichloride	$CH_2Cl.CH_2Cl$	Liquid	84
Ethylene dichloride-carbon tetrachloride 3-1 mixture (ECM or chlorasol)		Liquid	–
Ethylene oxide	$(CH_2)_2O$	Gas	11
Ethylene oxide – carbon dioxide 1-7 (or 9) mixture (carboxide)		Gas	–
Hydrogen cyanide (hydrocyanic acid)	HCN	Liquid	26
Methyl bromide	CH_3Br	Gas	4
Sulfur dioxide	SO_2	Gas	–10

TABLE 23. – Fumigants tried experimentally but little or not used commercially

Name	Formula	Boiling point, °C.
Acrylonitrile	CH_2CHCN	78
Ethylene chlorobromide	CH_2ClCH_2Br	107
Ethylene dibromide	$CH_2Br:CH_2Br$	132
Ethylene dichloride	CH_2ClCH_2Cl	84
Isopropyl formate	$HCOOCH(CH_3)_2$	71
Methylene chloride	CH_2Cl_2	40
Methyl formate	$HCOOCH_3$	31
Propylene dichloride	$CH_2ClCHClCH_3$	97
Tetrachloroethane	$CHCl_2:CHCl_2$	146
Tetrachloroethylene	$CCl_2:CCl_2$	121
Trichloroethane	CH_3CCl_3	74
Trichloroethylene	$CHCl:CCl_2$	87

NOTE: These are all liquids at ordinary temperatures.

CARBON DISULFIDE

This fumigant is cheap, relatively nontoxic to human beings, but very toxic to insects in the proper concentration; its presence is readily detected by its unpleasant smell. Its great disadvantage is its high inflammability. It is as inflammable as petrol and its vapor mixed with air and ignited, explodes. For the fumigation of small quantities of dates in a box in the open, away from flames, electric switches, dynamos and other sources of sparks, it is useful.

HYDROGEN CYANIDE

This fumigant, which was at one time widely used for the fumigation of dates, is an excellent killer of insects, including scales, which are resistant to many other fumigants, but its use has been almost, if not completely, discontinued for dates, owing to its extreme toxicity to man. It is also very soluble in water.

CARBOXIDE

Carboxide, also called guardite, is a mixture of seven or nine parts of carbon dioxide to one part of ethylene oxide. It is not very toxic to man and is a good killer of insects, but it has the disadvantage of being active chemically and of being quickly absorbed by moisture.

ECM OR CHLORASOL

This mixture is composed of three parts of carbon dichloride to one of carbon tetrachloride. The second constituent is a fire extinguisher and its presence makes the mixture noninflammable and nonexplosive. It is a moderately efficient insecticide and only slightly toxic to man, but it is rather slow and does not vaporize very readily. It is the best fumigant for use in the field by inexpert persons, especially in hot weather when evaporation is quicker.

METHYL BROMIDE

Various physical properties of this fumigant and useful conversion factors (May and Baker, 1959) are listed on p. 153.

Boiling point	3.6°C.		38.5°F.
Specific gravity at 0°C.		1.732	
Volume per lb. " "	262 cc.		16 cu. in.
Volume per kg. " "	576 "		35 " "
Vapor density at 20°C.	3.27 times air		

At 20°C. and 76 cm. pressure:

1 mg. per liter ..... = 1 oz. in 1.000 cu. ft.
= 253 parts per million

1 % by volume ..... = 39.5 mg. per liter
= .04 oz. per cu. ft.

17 parts per million... = 0.067 mg. per liter
= 0.067 oz. in 1,000 cu. ft.

Methyl bromide has been the chief fumigant for dates for the past 15 years and is now almost the only one used in large, modern packing houses. It is an excellent insecticide, penetrates and kills well and quickly, is noninflammable and nonexplosive, and it is only slightly soluble in water. It has no corrosive action on most metals, though it attacks aluminium. It disperses readily during ventilation after fumigation. It is, however, extremely poisonous to human beings.

The British Home Office specify 17 parts of methyl bromide in 1 million of air as the safe limit of concentration for prolonged human exposure to it. It is fortunate that its presence in such a low concentration can be detected quite simply. A kerosene lamp or stove normally burning with a nearly invisible blue flame is used. In contact with the methyl bromide in the air, the flame turns green. A gas mask must be used by persons likely to come into contact with the gas in greater concentration than that specified by the Home Office. The absorbent pad in the mask needs frequent renewal, the rubber parts need frequent inspection and replacement if perished.

The odor of methyl bromide, which is rather sickly sweet, is noticeable only at high concentrations. Consequently, a warning, lachrymatory gas, chloropicrin, is frequently added to the methyl bromide at the rate of 2 percent.

The penetrating power of methyl bromide has already been mentioned. An illustration of this power is given by Hill and Border (1953), who found that in 24 hours at a dosage of 20 milligrams per liter (20 ounces in 1,000 cubic feet), methyl bromide would penetrate wood 3.8 centimeters (1.5 inches) thick, in quantities sufficient to kill the grain insects on the reverse side.

The usual dosage for dates in ordinary, airtight, well-constructed stores is 185 milligram-hours per liter at 15°C. For 24 hours this would be 7.7 milligrams per liter, or 7.7 ounces per 1,000 cubic feet, and for 12 hours it would be 15 milligrams per liter or 15.4 ounces per 1,000 cubic feet. For every drop of 3°C. in temperature, the time × quantity product should be increased by 25 percent.

Methyl bromide can be obtained in 20 cubic centimeter glass ampoules, in 1-pound cans, and in cylinders ranging in capacity from 3 to 810 kilograms (12, 25, 30, 60, 140, 180 and 1,800 pounds).

Recently (December 1959), Kazmaier and Fuller report results of the fumigation of the Confused Flour Beetle, a Tenebrionid pest of stored dates, with mixtures of methyl bromide and ethylene dibromide (CH_2Br-CH_2Br). They used dosages of 8, 10 and 12 milligrams per liter for five hours and five different mixtures of the fumigants, as well as each separately. Most of the mixtures were more effective than either fumigant alone. Used alone, ethylene dibromide was much more effective than methyl bromide against adults, larvae and pupae, except against larvae when deaths were counted only one day after fumigation, but after two days the dibromide re-established its superiority.

ETHYL FORMATE

Ethyl formate is a useful auxiliary fumigant for use when a shipment of dates has to be rushed and when there is no time to fumigate in the usual way in the fumigation chamber or chambers, or when cases of dates have been removed from the chamber and left stacked and exposed to insect attack for some days before dispatch.

The fumigant can be sprinkled onto the lining paper of the case, the dates immediately poured in and the case closed, or if the lid has already been nailed on the case, the fumigant can be squirted into the case with a veterinary syringe through the cracks around the ends of the cases. The cases, of course, should be stacked only two deep, with the ends outward.

Because of its higher boiling point, ethyl formate is easier to handle than methyl formate and is nearly as effective a fumigant. The usual dose in warm weather is about 1 cubic centimeter for 1.6 kilograms of loosely packed dates, say 775 cubic centimeters in 1 cubic meter of stacked cases: 1,000 cubic feet of cases, therefore, would need 22 liters of the fumigant.

It will be seen that even without counting the cost of labor, this method of fumigation is expensive and is to be recommended not as the standard routine but only in special circumstances.

INDICATORS

As mentioned previously, chloropicrin, a tear gas, extremely irritating to the eyes and to the mucous membrane of the respiratory tract, and itself a fumigant, is commonly sold mixed with methyl bromide at a concentration of 2 percent, in order to provide a warning of the presence of the much less perceptible bromide. It has been used for the same purpose for other dangerous but not strong-smelling fumigants. Similarly, sulfur dioxide has been used with such fumigants.

Chambers

SITE

Unless heat treatment or cold storage makes fumigation unnecessary, dates need to be fumigated between their delivery at the unloading ramp of the packing house and their arrival at the processing and packing hall, that is, on the main floor of the plant. Similarly, unless special reasons make it unnecessary, dates need to be fumigated between packing and shipment. Therefore, in order that labor is not wasted on avoidable handling, the fumigation chambers or storerooms should lie between the unloading and loading ramps and the main floor. It is not necessary to have separate chambers for incoming and outgoing dates.

In order to keep the size of each chamber small, the whole of one side or of two sides, or even of three sides of the main floor may be taken up with fumigation chambers, but even then there may not be room in the chambers for all the dates delivered to the packing house at the peak of the harvest season. Californian packers, therefore, stack those incoming dates that cannot be accommodated in the chambers outside the packing house and cover the stacks with plastic paulins, under which the fumigant is introduced. Such paulins are also used in the new government date-packing house in the Sudan (Figure 79).

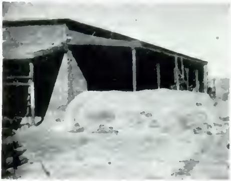

FIGURE 79. – Tarpaulins used in the Government Date-Packing House in Kareima, Merowe, Sudan, to cover dates in sacks fumigated outside the packing house.

SIZE

It is desirable that the total capacity of the fumigation chambers should be sufficient to accommodate all the dates that arrive at the packing house at the peak of the season.

Accommodation under paulins can be regarded as only a temporary expedient, but justifiable if lack of capital temporarily prevents the erection of permanent storage. It is also desirable that the capacity of each chamber should be small, possibly enough for one or two days' work, so that the dates enter the packing floor freshly fumigated and there is no wastage of fumigant by the use of a large chamber for only a small quantity of dates. Furthermore, as recommended in the previous section, it is advisable to have the inner doors of the fumigation chamber opening directly onto the main packing floor. All three conditions, however, even if three of the sides of the floor are taken up with fumigation chambers (and to use up three sides in this way would present inconveniences) could normally not be met; either some of the chambers must be placed elsewhere, or some of them must be made larger than the size necessary for only one or two days' work.

Barreveld's graphs (1959) (appendix 11) illustrate how storage requirements over a season can be calculated from a graph showing receipts of dates and sales. Packing goes on for a long time, but the period during which dates are received at the packing house is short. As an example, let it be supposed that a packing house receives 2,000 tons of dates in a season, but this quantity may be received in only 40 days. Sales, however, may not be completed until 200 days after the first dates are received, and they may be slow in starting, so that it may be that at the peak receipt time, about 20 days after the season opens, storage must be found for about 1,500 tons of dates.

To continue with this example: If the daily output of dates were 12.5 tons, including refuse, and the small fumigation chambers opening onto the main floor were to hold a two-day supply of dates; if the main floor were 50 meters square and each store were 5 meters wide, there could be built (excluding wall space) 20 such stores on two sides of the floor, containing in all 500 tons of dates. There would still be required a store, or stores, holding about 1,000 tons of dates. In the particular example under consideration a compromise between conflicting desiderata could be effected by having ten small chambers (4.5 × 3 × 4.5 meters) along one side of the floor (250 tons) and ten larger ones, each approximately 4.5 × 4 × 14 meters (1,250 tons) along another.

The relationship of weight to volume of stacked, loose dates is roughly half a ton to a cubic meter. This is the one used in the above calculations. However, if the dates come loose from the gardens to the packing house and are then packed in tight blocks, the space required for the packed dates will be less than that required for the unpacked ones. If, on the other hand, in repacking houses, the dates arrive in tightly pressed bulk blocks and are repacked in semiloose, small packs, then more storage space is required for the repacked dates than for the incoming dates in bulk.

Daglat Nuur dates lightly loaded in shallow boxes naturally need more space than firmer dates in deeper boxes.

SHAPE

In the previous section, " Factors Affecting Efficacy, " it was mentioned that of all practical shapes for a fumigating chamber a cube would be best for diffusion. It was added that the cube is satisfactory only for a small chamber, because of difficulty of stacking lug boxes very high. There are, however, two other disadvantages in a large cubical, or in a large square chamber, namely (*i*) the difficulty of fitting in several wide stores into the available space along one side of the main floor of the packing house; and (*ii*) the greater difficulty in exhausting a big square chamber than a long, narrow one. With the long, tunnel-shaped chamber, the door occupies a large proportion of each end wall. Consequently, when the outer door is opened and the exhaust fan is started up at the inner end, there is a stronger draft through the whole stack of dates than there would be if the cross section of the chamber were greater.

For stacking lug boxes which are open on top and which sometimes have the ends a little higher than the sides, a height of 4 meters is satisfactory; higher than that the stack may be unstable. For fibreboard cases, unless they are reinforced, the height should be less. To have as many chambers as possible opening onto the main floor, and to preserve the tunnel effect, the width of the chamber should be kept narrow, say, from 4 to 5 meters. The length of the chamber can then be varied at will in order to provide the capacity required.

CONSTRUCTION

The floor should be concreted. Removable slats are recommended to allow passage of the fumigant under the stack of date boxes and the floor to be cleaned easily when the chamber is emptied. The floor should preferably be at the same level as the loading and unloading ramp and as the floor of the main processing and packing hall. If it is not possible to have all three floors at the same level, then easy ramps (not steps) should lead from one to the other, to permit the passage of trucks.

The walls should be of masonry or brick (not of wood), because wood, though usually cheaper than other materials, is less durable, more inflammable, and is harder than the others to make impermeable to the air. Plain brick walls are not airproof. They must be plastered on the inside and the plaster varnished or painted with two coats of a good quality, high-gloss paint. Thin metal sheets can also be used for proofing and so can bituminized paper, but this, unless protected, will be torn during stacking and unstacking the boxes of dates. May and Baker (1959) recommend for filling up cracks (*i*) masking tape; (*ii*) bituminized paper; (*iii*) a putty made of three parts of calcium chloride, eight parts of powdered asbestos, and four parts of water; or (*iv*) wet, pulped newspaper.

The roof should preferably be flat for ease of making it airtight, and coated on the inside with the same proofing material as the walls. The common, wired, hollow-tile roof is good, light and cheap.

The doors (Figure 80) that are used for fumigating chambers are commonly of the refrigerator type. They are massive and provided with special hinges which enable them to fit tightly into the door frame all round. The disadvantages of such a door are its weight, high cost, and the difficulty that arises from its bottom edge having to press against a threshold,

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that is, the bottom of the door frame, and yet having to swing out above the level of the ground when it is opened. The threshold, therefore, has to be above ground level and thus presents an obstacle to the passage of trucks.

A door which has none of these disadvantages is one that has no hinges or locks. It is constructed of two layers of five-ply wood separated by a beech, or other suitable, internal frame. All four surfaces, that is, the two outer and the two inner ones, are well varnished to make them airtight. The bottom of the door frame is sunk a short distance below the floor in a shallow trough. The door frame is provided with a soft, rubber joint all round. The door is lifted by hand and placed against the frame. It is held against the frame by the pressure exerted by four transverse bars which fit into metal hooks projecting from the wall on either side. These hooks are provided with hand screws that enable the pressure to be applied. When the door is removed to allow the chambers to be loaded or unloaded, a metal flap falls over the trough which contained the bottom of the door when it was shut, to permit the free passage of trucks carrying cases of dates.

CIRCULATING FANS

At the beginning of the season, when the dates are arriving at the packing house slowly, and when orders are waiting to be filled, it is desirable to be equipped to fumigate the dates quickly. Fumigation can be accelerated, especially in cold weather, by hastening the preliminary diffusion of the gas employed, and this can be brought about by the use of circulating fans just before and for half an hour after the commencement of fumigation. As the usual fumigants are heavier than air, the fan, or fans, can conveniently be placed in a vertical tunnel or in vertical tunnels, in a corner or in the corners of the chamber. The tunnels are open at the top and bottom and are designed to draw the air upward.

A fan is also useful to hasten the evaporation of a liquid fumigant, but as liquid fumigants are not now much used in packing houses, it is more in the field that a fan is sometimes valuable, if there is a convenient electricity supply.

If inflammable or explosive fumigants are used in the chamber, the motors of the circulating fans must be outside the chamber and the shaft through the wall must be well packed to prevent the escape of gas.

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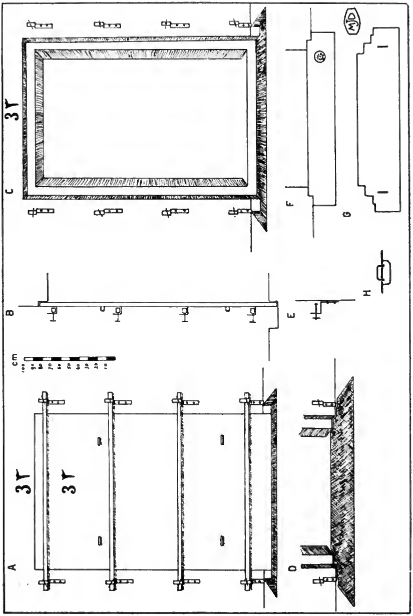
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EXHAUST FANS (Figures 81 and 82)

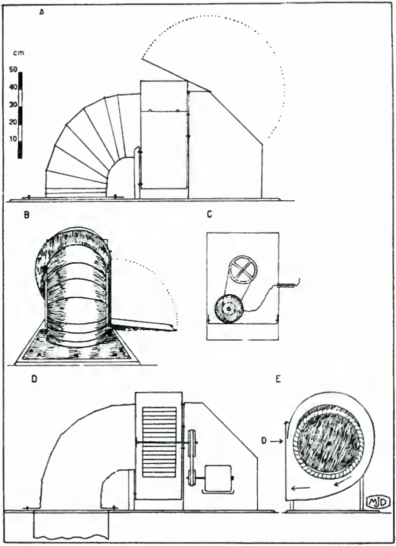
Another aid to quick fumigation is the exhaust fan. By its use, the poisonous gas can be withdrawn from the chamber in a shorter time than would be required if diffusion only were relied upon. The exhaust fan may conveniently be placed on the roof of the chamber, but its supply pipe should suck from close to the bottom of the store, since, as has already been mentioned, the fumigants commonly in use are heavier than air. The fan should be near to the door opening from the chamber to the main floor. A satisfactory type of fan is the power blower, the long, narrow blades of which form the periphery of a rapidly revolving cylinder. The size of a fan should be sufficient to exhaust in a few minutes the entire quantity of air in the chamber, but it should be run for long enough with the outer door open, that is, the one onto the loading ramp, so that the air in the chamber is changed 60 times before the boxes are removed. Thus if the air were changed every minute, a fan with a capacity of 600 cubic meters of air per minute would be required in a chamber measuring 30 × 5 × 4 meters. With such a fan, the reduction in the concentration of methyl bromide, for example, from the 4,000 parts per million, ordinarily found in a chamber under fumigation, to the 20 parts that is considered harmless in the United States (see Ingram, 1951), is effected in one hour; but a fan of such capacity is expensive. It is preferable to install one of one tenth the capacity, therefore taking ten times as long to degas the chamber, and to arrange the work flow so that the extra time taken does not cause delay on the packing floor.

The air exit needs a flap, or door, that can be shut tight to prevent the escape of fumigant and the entry of insects when the fan is idle, but which can be readily opened when the fan is working.

FIGURE 80 (*left*). – Constructional details of door of a fumigation chamber. Government Date-Packing House, Tripoli, Libya.

A. Door closed; door is kept in place by wooden bars and pressed tightly against the jamb by means of hand screws in the brackets. B. Vertical section of door showing channel containing the bottom of the door, which is thus enabled to make a tight fit all round the frame, including threshold, without the necessity of a raised threshold which would prevent passage of trucks. C. Door open, surfaces of frame and threshold which come in contact with inside face of door are lined with strips of foam rubber. D. Bottom of doorway showing metal plate fitted over channel which allows passage of trucks. E. Vertical section of bracket, which supports wooden bar, and hand screw which presses door in place. F. Plan of channel showing drainage hole. G. Plan of metal plate which is raised by means of two handles which lie flush with surface of plate when not in use. H. Vertical section of metal plate, showing one of its three legs and one of its two handles raised, ready for lifting.

(Courtesy Mrs. Joy Dowson



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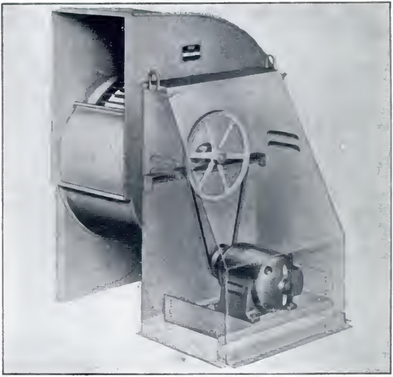

FIGURE 82. – A satisfactory exhaust fan for a fumigation chamber. California, United States.

FIGURE 81 (*left*). – Constructional details of exhaust fan on roof of fumigation chamber. Government Date-Packing House, Tripoli, Libya.

A. Front elevation, door of motor compartment open. B. View from left, showing plate at base of cowl bolted to concrete footing. Door of fan compartment open to let out exhaust fumigant. C. Vertical section, side view, of motor compartment, seen from right. D. Vertical section, front view, showing cowl, fan and motor. E. Vertical section, side view, showing fan and opening from cowl (shaded) in background, seen from right. The door is opened to let out exhaust fumigant when fan is working.

(Courtesy Mrs. Joy Dowson)

HEATING

Means of heating the fumigation chamber have been advocated but, with methyl bromide, which is an active insecticide at a wide range of temperatures, the cost of the installation of a heating system is not justified. Even with this fumigant, however, for a drop of 6°C., from 16°C. to 10°C., the quantity × time product must be doubled. The installation of a heating system might therefore be expected to hasten fumigation and to economize in fumigant but, in fact, it would not do either very much. Dates normally reach the packing house during the harvest season, when the weather is hot. The dates which are worked during the winter, therefore, should have been fumigated at a sufficiently high temperature for the fumigation to have been effective, while in the repacking houses of Europe and North America, the dates reach them when the weather is cold, and they are immediately put into cold storage.

FUMIGANT SUPPLY

The supply which, it is presumed, will be from cylinders of a gaseous fumigant under such high pressure that it is in a liquid state, should be admitted from the ceiling of the chamber if the gas is heavier than air. It

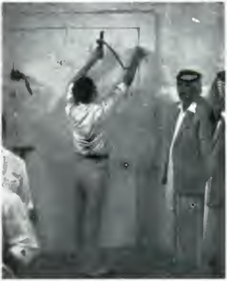

FIGURE 83. – Fumigation with small can of methyl bromide. The open end of the copper tube is inside the fumigation chamber. The operator holds the can outside the chamber door. Date Association Packing House, Baghdad, Iraq.

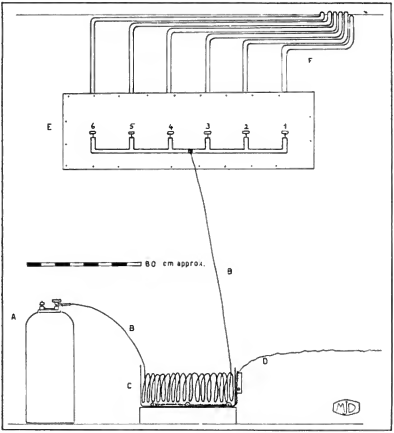

FIGURE 84. – Detailed sketch of control room of fumigation chambers. Government Date-Packing House, Tripoli, Libya.

A. Cylinder supplying fumigant which passes in copper tube B. through water bath C, heated by electric coil D, and is fed to the six fumigation chambers through pipes F. Cocks on control panel E regulate the flow of fumigant to each fumigation chamber.

(Courtesy Mrs. Joy Dowson)

is therefore advisable to have the cylinder on a truck on the roof, so that it can be wheeled from one fumigating chamber to another and connected as required with the main supply pipe fitted into the center of the roof of each chamber (Figure 83). From the main inlet in the roof of each cham-

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ber, the gas passes into a pipe running the whole length of the chamber and provided with numerous small outlets. If, on the other hand, the cylinder of fumigant is kept in a special room, there must be a long pipe from it to the farthest chamber, so that as the pressure is reduced at the valve at the top of the cylinder, the fumigant passes only slowly down this pipe to the chamber. The special control room (Figure 84) for housing the gas cylinders has, however, the advantages of convenience, shelter from the rain, and safety. In some packing houses the cylinder is wheeled on a truck through the packing floor and the chambers fumigated through holes in the inner doors, but this practice is not without danger and is not to be recommended.

Method

VACUUM VERSUS ATMOSPHERIC

The two main types of fumigation, that in a vacuum chamber and that in a chamber at atmospheric pressure, have been mentioned. It is now convenient to explain the reasons that made vacuum fumigators for dates popular 30 and 40 years ago, and those that have caused their virtual disappearance from the date industry at the present time.

Thirty years ago, hydrogen cyanide was the most popular fumigant for dates, and vacuum fumigation provided a simple way of obviating the outstanding disadvantages of this gas, that is, its extreme toxicity to man.

One of the pioneers of the Californian date industry lost his life fumigating with this gas in an ordinary, atmospheric chamber. With the vacuum fumigator, the gas is sucked straight into the closed chamber and after fumigation it is pumped out by an electric pump through a pipe projecting above the roof into the open air. The vacuum caused the gas, which at atmospheric pressure diffused poorly, to penetrate the dates quickly and completely.

For small lots of dates, vacuum fumigation is quick. The whole operation, including loading, exhausting, fumigating, admitting air and unloading, can be completed in an hour in a small fumigator, but for a large quantity of dates, that advantage over the nonvacuum chamber disappears. For instance, if 15 tons of dates have to be fumigated in a $^1/_2$–ton vacuum fumigator, the time needed would be 30 hours. An ordinary chamber of 15–ton capacity could be fumigated at atmospheric pressure in 24 hours, and the clearing away of the fumigant by the exhaust fan could be completed in another six hours, so that, at the end of 30 hours, equal quantities of dates would have been fumigated and cleared of gas by both methods.

A chamber of 15–ton capacity is much cheaper to build than are the purchase and installation of a ½–ton vacuum fumigator with pump, motor, piping and gauges.

Delassus and Lepigre (1935) quote Vayssière (1929) as mentioning the existence of a vacuum chamber in Mexico 70 meters long by 5 meters in diameter, and able to accommodate two railway freight cars at the same time; but this was not used for dates. Delassus and Lepigre do not state the time such an enormous tunnel took to exhaust; it must have been long. For dates, the biggest vacuum fumigating chambers now in use are probably those in Basra, which have capacities of several tons.

In spite of the greater cost of a unit of capacity of the vacuum fumigator compared with that of an ordinary fumigation chamber, the use of the vacuum fumigator would perhaps not have been superseded by the other had not methyl bromide been discovered as a gas and, moreover, as one which diffused quickly and penetrated at atmospheric pressure into tightly packed dates in closed packages to a remarkable degree.

APPLICATION

Methyl bromide and other fumigants commonly marketed in steel cylinders may be placed on a platform scale (Figure 85), in order that the weight of the gas being used for fumigation can be measured. The loss of the required weight may, however, be more readily observed, and from a distance, if the cylinder is slung from a spring balance with a clear dial. The balance can be suspended from a support fixed above a small truck if the cylinder has to be moved about.

Quicker measurement of the amount of fumigant required can be effected by connecting the outlet valve to the cylinder's liquid outlet and filling a graduated, pressure-glass cylinder in which the amount of liquid required can be measured by eye (Figure 86).

If the gas has to travel far through tubing (of copper, not aluminium, for methyl bromide) diffusion can be hastened by passing it through a coil in a water or oil bath, maintained at near boiling point by an electric heater.

For the small fumigation chamber, the cans of fumigant are convenient. A special applicator is used which, when fitted onto the can, which

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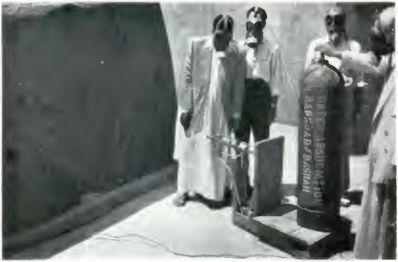

FIGURE 85. – Measuring amount of methyl bromide to be used by weight on portable platform scale. Date Association Packing House, Baghdad, Iraq.

is held by the operator outside the chamber and tightly connected with the supply pipe which passes through the wall or door of the chamber, pierces the top and allows the passage of the gas directly into the pipe without any loss into the atmosphere outside the chamber (Figure 87).

RESULTS

Fumigation of dates should result in the death of all contained insects and mites in all their stages; but the dead bodies remain in the dates, except those of some of the larvae of the genus *Ephestia* that may have been stirred into activity by the action of the fumigant at the beginning of a fumigation and have crawled out of the dates. Fumigation, therefore, is no cure-all and no substitute for grading and cleaning. Neither does fumigation confer on the dates immunity against reinfestation.

Another result of fumigation is the sorption of fumigant by the dates. Monro and Thomson (1929) found the amounts of hydrogen cyanide in various foods as listed on p. 170, immediately after ventilation subsequent to fumigation with this gas.

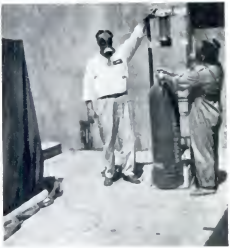

FIGURE 86. – Measuring out liquid methyl bromide by volume in glass pressure cylinder before fumigating stack of date boxes. Date Association Packing House, Baghdad, Iraq.

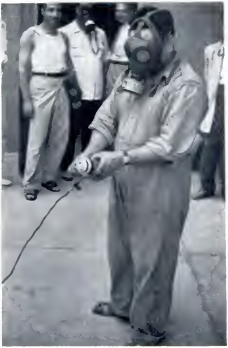

FIGURE 87. – Piercing the 1-pound can of methyl bromide (under pressure) by means of special device which releases the gas only into the copper tube and then into chamber. Date Association Packing House, Baghdad, Iraq.

Food	*Parts per million of HCN*
Chocolate	1
Agar Agar	3
Dates	5
Cocoa beans	12
Desiccated coconut	15
Walnuts	50
Cocoa powder	63

Sorption of methyl bromide in fumigated dates has been estimated to amount to 28 to 56 parts per million, but much of this is desorbed on airing.

Dates that had been aired for a week after fumigation with this gas for various periods at various doses contained residues of bromine ranging from 6.8 parts per million to 7.9 parts (Lindgren and Vincent, 1953), while Armitage and Steinweden (1945) found 20 parts of bromine in a million parts of dates 12 days after an ordinary fumigation.

Lindgren and Vincent found a residue of from 5.3 to 7.4 parts of bromine in a million parts of dates a week after fumigation with ethylene dibromide.

None of the above amounts of bromine found in dates after fumigation are considered harmful to human beings.

Recently the United States Food and Drug Administration have given attention to the matter of the bromine residue in dates after fumigation and it may be that the practice of leaving dates for a long period in an unopened store which has been fumigated with methyl bromide will not be allowed to continue (see p. 149).

Safety precautions

All fumigants used for dates are poisonous to man but they vary in their toxicity. Carbon disulfide, for example, is not a quick mankiller and has so unpleasant a smell, even in low concentrations, that handling it is not very dangerous. On the other hand, hydrogen cyanide, with a fainter and not unpleasant smell, and an almost instantaneous killer, is extremely dangerous.

Methyl bromide lies between these two extremes. It is very poisonous and can be rapidly fatal in high concentration. With low concentration, the symptoms of poisoning may be delayed for several hours. Graver symptoms may appear after some days, and " long-lasting or permanent mental and nervous changes may result " (Ingram, 1951). The usual symptoms of mild poisoning by methyl bromide are visual and vocal disturbances, mild mental confusion and numbness of the extremities (Johnstone, R. T., 1945).

The 200 cases of methyl bromide poisoning, mostly slight but many serious, among employees in the date-packing houses of the Coachella Valley in 1944 and the few cases there subsequently should be a warning to all concerned with the fumigation of dates of the danger of the process and of the necessity for the greatest care in its operation.

The following precautions should be adopted in every packing house which uses fumigation. They are designed for fumigation with methyl bromide but for the most part apply to other fumigants also.

1. The fumigation chamber should be gas-proof.

2. While fumigation is in progress, warning notices should be posted on both doors.

3. The exhaust fan should be run for a little while before the outer door is opened.

4. The outer door should be opened quickly and no one allowed near the open doorway until degassing is complete.

5. Unloading the chamber should not start until the air in it has been changed 60 times.

6. The exhaust fan should continue to work after degassing is complete as long as men remain in the chamber removing the boxes.

7. A halide, gas-detector lamp should be used to spot leaks.

8. A gas mask should be kept near the chamber in case of accidents. It should be inspected and its absorbent filters changed at regular intervals. There is no one filter that protects against all fumigants. For each fumigant the best filter available should be used. Dust masks are useless. No mask is any use by itself in an atmosphere deficient in oxygen. In such an atmosphere an oxygen cylinder must be carried also.

9. As there are no antidotes against methyl bromide poisoning, the only protection the worker has is prevention.

10. No liquid methyl bromide should be spilled. If by accident some is spilled onto clothes, these should be immediately removed and thrown into the open air. If the liquid falls on the skin, very thorough washing with plain water should be given at once.

11. Dressings to protect skin lesions should be easily accessible.

12. A person overcome by the fumes of methyl bromide should be removed to the fresh air and kept warm.

13. A doctor should be summoned for every case of poisoning, however slight.

14. Simple first aid instructions should be permanently displayed near the fumigation chamber.

Legislation

In Algeria, Iraq and Tunisia, regulations are in force compelling exporters of cased dates to have them fumigated before shipment. As regards Algeria, only the dates called " for consumption " are required to be fumigated. In Iraq, basket dates are not required to be fumigated nor, at least until recently, was there any regulation to prohibit the export of fumigated dates that had been lying about on the wharf so long that they had become reinfested.

It is probably good for the trade that governments should insist on the fumigation of dates, at least those in boxes, if not those in baskets, before shipment abroad or from one state to another, but it is obvious that shipment should either not be long delayed after fumigation, or the dates while awaiting shipment should be kept in an insect-free store.

In some countries regulations concerned with the safety precautions to be observed during fumigations have been promulgated, notably those in connection with hydrogen cyanide fumigation in several cities in the United States. The safety limit of concentration of methyl bromide in the atmosphere has been specified by various bodies. Thus in the United States, in 1945, under the regulations of the Industrial Accident Commission, the safety limit was defined at 50 parts per million, but in that year a recommendation was made to reduce it to 30 parts per million (Johnstone, 1945). By 1951 the safe limit was considered to be 20 parts per million (Ingram, 1951), while in the United Kingdom (Brown, 1954) 17 parts per million is generally accepted.

The attitude of the United States Food and Drug Administration toward the safe limits of fumigant residues in food may be judged from the following extract taken from a letter sent by the United States Department of Agriculture to P. Simmons *et al.* (1935), a part of which reads:

> " From the standpoint of the Federal Food Drug Act, the Food and Drug Administration is indirectly concerned about the nature of food fumigants. Under the food law, action would lie against consignments of foods shipped within its jurisdiction, which may contain such residual quantities of dangerous fumigants as to render the food harmful to health. Because of the important public health considerations involved, the Food and Drug Administration cannot consistently take any position with respect to the fumigation of foods except to regard every proposed process as potentially dangerous, unless or until it is definitely proved harmless. It cannot be expected to take the position... of at least tacitly approving a fumigation process until it is shown to be harmful. "

Definite standards were later laid down, and the permitted tolerances of pesticide residues specified. In the case of methyl bromide, permitted tolerances range from 200 parts per million for various nuts down to 5 parts per million for apples, pears and quinces; but there is no mention of dried fruit or dates. It may be presumed, therefore, that insofar as the fumigation of dates with methyl bromide in the United States is concerned, the attitude of the Food and Drug Administration is still that of 1935.

The attitude of the British Government to pesticide residues in general today is much the same as was that of the Government of the United States in 1935. Hinton (1960), writing of pesticide residues, states:

> " No regulations or orders have been made specifying tolerances for pesticide residues in food. There is the general responsibility under the Food and Drugs Acts that food sold for human consumption shall not be injurious to health. In view of the number of possible pesticide residues, and the absence of information on cumulative effects of most of them, as well as of the difficulties of analysis, control at present rests on the principle of preventing as far as possible their presence on agricultural products at the time of harvesting, and on stored food products at the time of use. "

In Canada, however, the limits for many pesticide residues in foods, including dried fruit, have been specified by regulations under the Food and Drugs Act (Pugsley, 1959). *CFAL Bulletin* No. 30 (31. xii. 59) gives a list of these as published in *Canada Gazette* (Part ii, No. 15, 12. viii. 59), from which it is learned that the permitted tolerance in Canada for methyl bromide in dried fruit is 20 parts per million, calculated as inorganic bromine.

Other practices for controlling insect infestation

Dipping dates into boiling water has already been mentioned above. Heat treatment will be discussed in a later section.

Covering the stacks of dates, especially if in unlidded cases, with paulins or shade cloths, prevents the adult females of the Fig Moth and its cousins from laying their eggs on the dates. Covering the stacks does not, however, keep away the small beetles which, although they can fly, generally walk to their food, and which can get through cracks in the wood through which the adult moths could not pass. Most of the beetles, however, can be kept out of a stack of dates for a time by means of a liberal sprinkling of DDT or cammexane powder on the ground before the stack is made, and all around the stack after it is in position.

An insect-proof lining paper in the packing cases would be a boon to packers, but there does not seem to be one on the market, although in 1921 Oishi and Kabushidi took out a Japanese patent (No. 38,494) for a paper which it was claimed kept insects out. The paper was treated with an alkaline solution or paste of cupric ammonium arginate.

Grading

Grading has two functions: (*i*) to separate dates into their different kinds; and (*ii*) to separate them from refuse.

Different varieties of dates are almost always brought into the packing house separately, so that any particular grading operation would normally be for only one variety of date. There are, nevertheless, two reasons why dates of any one variety, as received at the packing house, should be separated into their different kinds. Firstly, to produce lots homogeneous in respects of maturity and, secondly, if all the dates are more or less equally mature, then homogeneous in respect of quality. Thus Daglat Nuur in the *rutab* stage, that have been carefully handed down the palm and from the bunches of which the shrivelled dates and those attacked by insects have been removed in the garden, are likely to be almost all of good quality. When these dates are received at the packing house, grading would consist chiefly of their separation into lots, differing only in the stages of maturity of their component dates, in order that each lot be given the particular treatment required. On the other hand, dates that are allowed to ripen fully into *tamar* on the palm are usually nearly all in one stage of ripeness. Grading is then chiefly for the separation of the dates into different lots by size and color and for the elimination of shrivelled dates and other refuse.

As growing conditions vary from season to season, so do the prevalent types of refuse that have to be removed from the date by grading. Most years, for example, the packing house in Tripoli, Libya, has little trouble with unpollinated dates (*siis*) which do not ripen properly, but in 1956 these formed a large part of the rejects. In Basra, Iraq, in years of heavy flooding and of a humid packing season, the downriver Istaamraan (Sayir) have a black, softish ring round the calyx. Such dates tend to decay more rapidly than normal ones of the same variety, and consequently they have to be removed from the dates intended for the best packs. On the other hand, in the hot, dry years, black-based Istaamraan are to be found less frequently than dates with other defects, such as small size or too red a color. Again, in California, after untimely autumn rains, the chief type of packing house reject is the fermented date.

GRADING FOR MATURITY

Cutting bunches while the dates are in different stages of maturity

Not all the dates on a bunch ripen at the same time, so that those of varieties which are eaten in the soft stage (*rutab*) must be picked at frequent intervals.

To catch all dates in this condition may necessitate climbing the palm 20 times in a season. Such frequent climbing, possible for a few palms for home use, is not practical for the 20,000 tons of Daglat Nuur dates of North Africa, because there are not enough laborers available. Therefore, for this variety, and similar ones which are preferred in the late *rutab* or very early *tamar* stages, the usual practice in Algeria and Tunisia is for the whole bunch to be cut when about a third of the dates has reached or passed the required degree of maturity and the remaining two thirds are still immature.

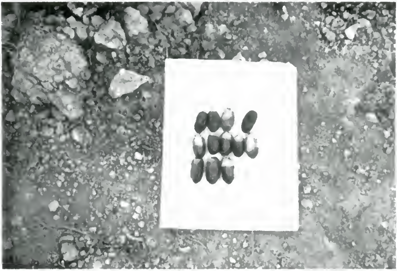

FIGURE 88. – Varietal differences: Istaamraan dates showing characteristic sharp line of demarcation between basal, unripe, *khalaal* half, and the apical, soft, ripe, *rutab* half.

Grading in the field or in the packing house is now necessary to separate the dates after they have been pulled off the bunch into different lots, as follows:

Hard, orange (*bisir*, *balah*, *khalaal*), which will need low heat to mature (Tate and Hilgeman, 1958).

Soft (*murattab*, *rutab*), which will need a higher temperature for a shorter time.

Mature (beginning of *tamar*), which will need no treatment.

Hard (*frezza*, mummified), which will need hydration.

Course of maturation

Maturation is a gradual and continuous process, so that the separation into different grades is necessarily somewhat arbitrary. There are, however, indications clear to the eye of three steps in the process; they correspond to the commencement of important changes in the appearance and composition of the fruit. These steps are: firstly, the change of skin color from green, when the date is called *kimri*, *chimri*, or *ghamag*, to yellow or red; secondly, the softening of the tip or apex of the date; and thirdly, the completion of this process over the whole date or over that part of it that normally softens (Figure 88).

Definition of maturity

In general, there is no agreement regarding the definition of maturity of a date. For instance, in the Fezzan (Libya), Taaliis dates are considered mature when still green, because that variety is sweet and not bitter at that stage, but the Daglat Nuur packer does not consider it mature until it is in the late *rutab* stage. The Basra packer, however, would reject *rutab* dates as immature and not accept anything but *tamar*. In general, therefore, it is better to employ the Arabic names or their equivalents to indicate the degree of maturity. " Fairly immature," a term which appears sometimes in date literature, is to be avoided.

Green dates

As was mentioned earlier, another source of terminological confusion is the practice of some American packers and writers who use the term " green dates " for those which, for their purposes, are immature, even though the actual color of the date is anything from pale lemon yellow, through rose and amber, to cinnamon and hazel. The term " green dates " should be confined to dates that are really green in color; but, to prevent further confusion, the reader is reminded of what has already been mentioned on p. 28, namely, that there are a few varieties of dates which, although they pass through the normal, hard, bright, pea-green *kimri* stage and then through the hard, yellow *khalaal* stage, yet in the *rutab*, that is the soft stage, they are of a dull, sea-green color, instead of the usual brown. Such are the Khadhraawi of Iraq and the Khadrai of Libya. Both names, which are derived from the Arabic word *akhdhar*, meaning green, draw attention to this peculiarity.

A suggested classification of ripening stages for dates, except for those of the Daglat Nuur variety and for hard dates, is given in Table 24.

The term brown denotes any color from deep buff to mahogany, deep purple or black, according to variety or other circumstances.

The term hard applies to dates common in the Sudan and the Fezzan but less so elsewhere, which have a high sucrose content and pass straight from the hard *khalaal* to a hard *tamar* stage, with little or no softening in between. Examples of these dates are the Zahdi and Ashrasi

TABLE 24. – Suggested classification of ripening stages, excluding those of Daglat Nuur variety and hard dates

Stage	(1)	(2)	(3)	(4)
Size	Fully grown	Fully grown	Fully grown	Begins to shrink
Color	Green	Yellow, chrome, pink, or red	Yellow, chrome, pink or red	Tip brown
Depth of color	—	Pale or somewhat paler than next stage	Deeper, fully colored	—
Consistency	Hard	Hard	Hard	Hard, tip soft
Arabic name	*Kimri*, *chimri*, or *ghamag*	*Khalaal*, *balah*, or *bisir*	*Khalaal*, *balah*, or *bisir*	*Rutab*, *murattab*
Stage	**(5)**	**(6)**	**(7)**	**(8)**
Size	Continues to shrink	Continues to shrink	Continues to shrink	Stable
Color	Tip half brown	All brown	All brown	All brown
Consistency	Half hard, tip half soft	Soft	Pliable	Prune-like, leathery
Arabic name	*Ritab*, *Nusf wa nusf* (Figure 88)	*Rutab*	*Tamar*	*Tamar*

of northern Iraq and the Sukri and the Hallaawi in its *abul khusheim* condition in the south, already mentioned on p. 30. Hard dates would be included in Nixon's class of dry dates.

Table 25 (p. 180-181) shows the stages in the ripening of the Daglat Nuur variety.

REFERENCE NOTES FOR TABLE 25:

The table has been adapted from the one by A. Monciero, 1954 (columns headed M); from that of Sievers, A. F. and Barger, W. R., 1930 (columns headed S); and from Wertheimer, M., 1954 (columns headed W).

Sievers and Barger use Ridgway's color standards (1912) and Monciero uses Séguy's (1936). Hence arise differences between the names of the colors. Furthermore, for instance. Monciero in his Stage 8 states that

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one side of the date is green. However " green " is only the title of Plate 23 (Séguy), on which there are 15 colors. Monciero then gives only the reference number (No. 337), without mentioning that Séguy calls this " ochre, " which is at least closer to Ridgway's " hazel " than " green " would be (see Robert Ridgway. Color standards and color nomenclature, *Washington D. C., 1912; E. Séguy,* Code universel des couleurs, *Lechevalier, Paris, 1936).*

GRADING FOR SIZE, COLOR, ETC.

Dates of different varieties differ from one another in the various attributes which together determine quality, namely, uniformity, size, shape, color, skin (thickness, tendency to break, adhesion to flesh), flesh (texture, consistency), rag (amount), pit (size), flavor, and cap (perianth, presence or absence). Once, however, the packer has decided on the variety he wishes to handle, then of the above attributes the only ones with which he has to concern himself, assuming that the particular lot of dates under consideration are all equally mature, are size, color, breaks in the skin and presence or absence of the cap. He has now to determine what is the greatest variation in each which his market will tolerate and to tell his graders the limits which he has set. Dates in excess of these limits must be rejected. Thus, for example, if the packer is advertising his product as " Golden Dates " and is using the Basra Hallaawi to supply his market, his graders must reject Hallaawi which are too dark in color. Again, if the packer intends his dates for a fancy pack of large dates, a certain number of which appropriately arranged fill a particular carton, he must reject dates falling below the required size.

Small dates may be of as good quality as bigger ones, but shoppers buy by eye, and small dates generally fetch a lower price than big ones. The presence of small dates among big dates lowers the value of the lot.

The rejects from a pack destined for one market may be readily acceptable to another. Thus Hallaawi white-shouldered dates, whose sucrose in the basal part has not been inverted to the same extent as in the apex, the " putty ends " of the American market and the *abul khusheim* of Basra, are not acceptable by the New York repacker, who requires for his cartons a uniform " date " color. They are, however, readily sold in India, Pakistan and elsewhere when pressed into baskets.

TABLE 25. – Stages in the ripening

Month	M 11 Stages	S 9 Stages	Name, color				
W	M	S	M	S	M	M	W
1-15.VIII	1	—	Green	—	Green	—	—
15-31.VIII	2	A	Red *balah*	Full rose	Red	XI 158 * Red	Begins to turn pure yellow or reddish yellow
	3	B	Half red half orange-yellow *balah*	Half rose	Half red half orange-yellow	XI 158 Red XV 212 Orange	
	4	B	Orange yellow *balah*		Orange yellow	XV 212 Orange XVII 246 Yellow	
IX	5	C	*Balah* slightly *murattab*	Rose shoulder	Apical ripening spot	XIII (193)– Orange	Softening begins at tip and color changes from yellow to light amber or brown. Becomes wrinkled and flattened
	6	D	Early *murattab*	Turning	Half waxy translucent	XIII (193)–192 Orange	
	7	E	*Murattab*	Soft ripe	Waxy translucent	XIII (193)–191 Orange	
	8	F	Late *murattab*	Soft wrinkled	Beginning of drying	XIII 193 Orange on one face (less waxy) XXIII 337 Green on other	
X (Harvest)	9	G	Normal ripe soft	Soft wrinkled	Ripe	XI 162 Red uniform	
	10	H	Normal ripe dry	Semidry	Ripe, somewhat dry	—	
XI	11	—	*Frezza*	—	Ripe, dried up	—	

* The numbers are from E. Séguy's *Code universel des couleurs*, Paris, Lechevalier, 1936.

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of the Daglat Nuur date

and texture				Color of ring at stem end	Approximate amount of ragat shoulder %	Relative ease of ripening	Broad maturity classification
Apical	Half	Basal	Half				
Color	Texture	Color	Texture				
S	S	S	S	S	S	M	M
—	—	—	—	—	—	Impossible to ripen after separation from palm	Immature
Rose to amber	Hard to firm	Rose	Hard	Rose	100	Difficult to ripen	Immature
Amber	Firm	Rose	Hard	Rose	100	Difficult to ripen	Immature
Amber	Firm	Rose	Hard	Rose	100	Difficult to ripen	Immature
Amber to cinnamon	Yielding	Pale rose	Firm	Rose	100	May be ripened with care	Immature
Cinnamon to hazel	Yielding to pliable	Amber to cinnamon	Yielding	Pale rose to light brownish purple	50-75	May be ripened with care	Beginning of ripening
Hazel	Pliable slightly soft, translucent	Cinnamon to hazel	Pliable	No well-defined color	0-50	Can be ripened naturally on tray or in store	Beginning of ripening
Hazel to russet	Pliable	Hazel	Pliable	Some rose color, others no well-defined color	0–75	Easily ripened on tray	Beginning of ripening
Hazel to russet	Pliable	Hazel	Pliable	”	0-75	—	Ripe
Hazel to russet	Pliable to leathery	Russet	Pliable to leathery	”	0-75	—	Ripe (overripe)
—	—	—	—	—	—	—	Ripe (overripe) dried up

ELIMINATION OF CULLS AND REFUSE

Culls and refuse must be graded out of the dates before the good dates can be packed. Refuse consists of earth, sand, stones, date perianths, date spikelets, nails, etc. Culls are dates which are too immature to be matured artificially, or which have been damaged mechanically or by moisture, pests, diseases, or contaminated by dirt. They may be roughly classified under the causes of the damage as follows:

Mechanical

Holed by date palm spines (*manguub*).

Squashed (*mamruud*).

Contaminated too much to be cleaned, by soil or sand having entered through the hole left by the absent cap, or through a crack in the skin, or having stuck onto the exposed flesh of a sun-dried, half date.

Bird (Figure 89)

Holed (*manguub*).

Insect and spider

A list of these pests is given below. Dates containing live insects or containing frass, cocoons, or the cocoons of predators (all classed together in Arabic as *musauwas*, i.e., infested) must be graded out (Figure 90), and so must those that have been holed or partly eaten away. As dates may reach the graders either from the garden or from store, the list includes pests that attack dates in both places.

Diseases, fungus

Once the skin of the date is broken mechanically, by bird, beetle or internal water pressure, fungus diseases attack the flesh if it is moist enough. Their black spores develop and make the date inedible.

Fermentation

Once the skin of the date is broken, the organisms causing fermentation attack the flesh if it is moist enough. The date rapidly sours.

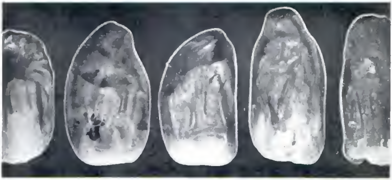

FIGURE 89. – Damage by birds. Basra, Iraq.

FIGURE 90. – Class for date infestation inspectors. Date Association Packing House, Baghdad, Iraq.

Physiological

1. Unfertilized dates (*shiis*, Iraq, *siis*, North Africa), which remain always in the *khalaal* (hard, shiny, yellow or red) stage.

2. "June drop" dates (*tujeij* or *humeira* in Iraq, *khafaar* in Bahrein, *bengaraat* in Iran), small, almost empty, with brittle, dull, red skin, are often found mixed with the good dates.

3. Shrivelled dates, called *hashaf* in Arabic, *kukk* in Panjabi, *chal* in Baluchi, *saleng* in Persian. The cause is an insufficient supply of water and presumably also of food materials. As Nixon and Crawford (1937), have shown, the cause of the lack of water, etc., may be the presence of more dates on the palm than it can properly nourish. It may also result from damage by borer (*Oryctes*) in the main axis of the bunch, or mechanical damage to the main axis, spikelet, or attachment of perianth to spikelet. The *humeira* is spherical and its skin is smooth, but the *hashafa* (singular of *hashaf*) is date-shaped and, with the evaporation of the moisture within it, subsequent to the injury of its pipeline, or under the pressure of competition from the other dates on the palm, is shrunken and deeply and firmly wrinkled.

The color may be green or dull red, according to the stage of ripening of the fruit at the time of picking (Figure 91).

4. Dates damaged by too much moisture, causing checking, splitting of the skin of the date mostly at the apex; blacknose, darkening of apex, associated with checking; splitting, more severe than checking, and black base.

Insects and mites damaging dates

Dates damaged by insects and mites must be eliminated from a bulk before packing.

INSECTA

Hemiptera (Scales, etc.)

Diaspididae. *Parlatoria blanchardi* Targ. The Parlatoria Date Scale (in Arabic *jidri* or *jarab*).

In severe infestations, this scale may attack the dates to such an extent as to make them unfit for human consumption, but usually, the attack

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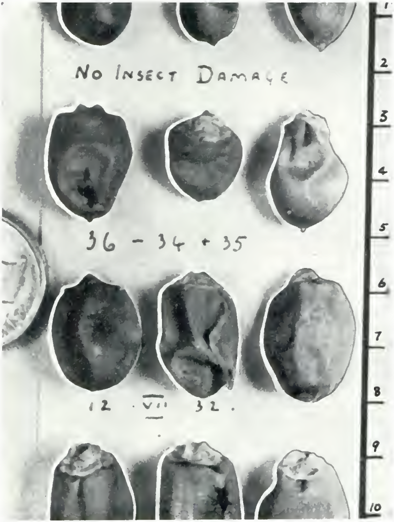

Figure 91. – " June drop. " Dry, small, immature dates. Some fall to the ground, but many remain attached to the bunch or are caught and held by the other dates, so that they are carried to the packing house and have to be graded. Called *tujeij*, *humeira*, etc.

is confined to the vegetative tissues of the palm. On the whole, an unimportant pest of the fruit. Occurs wherever dates are grown, except at present in the United States.

Margarodidae. *Icerya purchasi* Mask. The Fluted Scale.

Diaspididae. *Aspidiotus hederae* (Vall.). This and other scales occasionally disfigure dates. Unimportant.

Asterolecaniidae. *Asterolecanium phoenicis* Ram. Rao. A pest in Israel on the palm, but unimportant on the fruit.

Aspidiotus hederae. Iran, Iraq, Israel.

Lepidoptera (Moths, etc.).

Aegeriidae (Clear Wings). *Nemapogon granella* L. The European Grain or Wolf Moth. In store, unimportant, United States.

Cosmopterygidae. *Batrachedra amydraula* Meyr. The Lesser Date Moth. This moth concerns the grader in two ways. The dates attacked by the larva mostly fall to the ground when the bunches are bent down early in the year or when the bunch is shaken after being cut at harvest. They are not collected, but many attacked dates nevertheless remain in the bunch (Figure 92). These partially eaten dates are spherical, a centimeter or less in diameter, with a brittle, Venetian-red skin; hence their Arabic name, *humeira*, meaning the little red one. During grading, most fall through the meshes of the screens, especially if there are shaker screens in the grading line, but many break, and the pieces of dry skin stick to the soft dates and have to be removed by hand. The tiny larva burrows into the date at a point just under the overlapping calyx. Presumably it selects this situation for its entry because, as shown by Turrel, Sinclair and Bliss (1940), the date skin there has neither cuticle nor tannin layer.

The second way in which the larva does damage is by roughening a tiny, lunar patch on the skin of a date, when it is small, spherical and green, adjacent to the date into which it proposes to burrow (Figure 93). The attacked date is attached to the roughened skin of the neighboring one by a silken cord. In this way the date burrowed into does not immediately fall to the ground but remains suspended by the cord. The date to which it is attached grows normally except for the patch, which grows in size as the date grows, until, in the fully-grown date, it forms a black discoloration 4 or 5 millimeters in diameter (*munakkaz*). The skin of the discolored part is horny. When the fully-grown green date changes into the *rutab* soft stage, the black patch loses its black color and becomes buff but still remains hard.

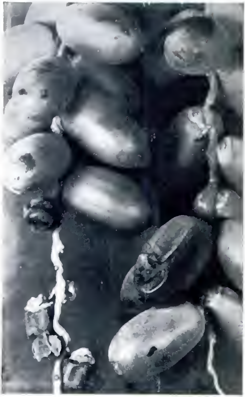

FIGURE 92. – At the bottom of the left-hand spikelet are five undeveloped, brittle, Venetian-red dates into which the Lesser Date Moth larvae have eaten their way. It will be seen that the two last dates are attached to the spikelet by a silk cord. This has been spun by the larvae to prevent the date from falling to the ground before the larva leaves it. Basra, Iraq.

For a choice pack, dates damaged in this way must be rejected. Serious pests in Iraq and Iran, but unimportant in Libya.

Phycitidae. *Plodia interpunctella* (Hbn.). The Indian Meal Moth. Lays eggs on dates on palm and on windfalls, but is chiefly a pest of stored dates. Live and dead larvae, frass and silk are found in the dates. More important on dates in the United States than on dates in the Old World. On palm in Libya (Martin, 1958). In store, cosmopolitan.

Spermatophthora hornigi Lederer. Larvae, etc., in windfalls and in store. Unimportant.

Ephestia calidella Gn. Larvae, etc., in dates. In the United Arab Republic eggs may be laid on dates on palm, and larvae may commence dep-

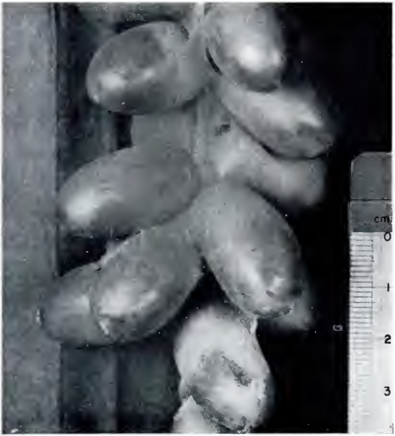

FIGURE 93. – The web spun over the green dates by mites. In the web, dust collects. The mites are a serious pest. Basra, Iraq.

redations there. Important pest in stored dates in parts of the United Arab Republic. Present but unimportant in Libya (Martin, 1955), Iraq.

E. cautella (Walk.). The Fig Moth. Larvae, etc., in dates. Eggs laid on windfalls and harvested dates in gardens awaiting transport to the packing house. The most serious cause of damage to stored dates in Iraq. Found on dates in the United Arab Republic and stored dates in Libya.

E. elutella (Hbn.). The Currant Moth. Larvae, etc., in dates. Eggs on windfalls. Unimportant.

E. figulilella Greg. The Raisin Moth. Larvae, etc., in dates in store. Eggs may be laid on dates on palm. Does much damage in California. Less important on dates in the United Arab Republic than *E. calidella*.

Myelois ceratoniae Zell. Larvae, etc., in dates drying and in store. A serious pest in parts of the United Arab Republic.

M. decolor Zell. Larvae, etc., in dates on palm and in store. An important pest in Algeria.

M. venipars Dyar. The Navel-Orange-Worm Moth. Larvae attack dates on palm and on ground. A minor pest in Arizona and in California.

Galleriidae. *Arenipses sabella* Hmps. The Greater Date Moth. The large larvae are voracious feeders and each destroys several young dates. The damaged dates mostly fall to the ground during harvesting, so that only a small part of them needs to be graded out. A serious pest of dates on the palm in Iraq, but although Buxton (1920) mentions that the larva is known to eat stored dates, this lacks confirmation. Martin (1958) reports it from the Fezzan (Libya).

Nemeobiidae. *Libythea bachmanii* Kirt. Near Winter Haven, Texas, occasionally covers dates with its wing scales, which adhere tenaciously and ruin the appearance of the dates.

Coleoptera (Beetles)

Nitidulidae (Sour Bugs, etc.). In addition to damage caused by direct feeding, the insects are also said to be carriers of fungi and other microorganisms from infected to noninfected dates.

Carpophilus decipiens Horn. United States. Unimportant.

C. dimidiatus F. The Corn-Sap Beetle. Attacks dates on palm, windfalls, and dates in store. The larvae, pupae, adults and frass are found in dates. A serious pest. United States, Libya, Iraq.

C. hemipterus L. The Dried-Fruit, or Fig, or Two-Spotted Beetle. Habits similar to *C. dimidiatus*. A serious pest. United States, Libya (Coast and Jufra, Martin, 1958), Egypt, Iraq.

C. humeralis F. Unimportant.

C. immaculatus Luc. Unimportant.

C. maculatus Murr. Unimportant.

C. obsoletus Murr. Unimportant. United States.

Glyschrochilus fasciatus Ol. Unimportant. United States.

Haptoncus luteolus Er. The Yellowish Nitidulid. Habits similar to *C. dimidiatus*. Pest of lesser importance. United States.

Urophurus humeralis F. The Pineapple Beetle. Habits similar to *C. dimidiatus.* Minor pest. United States.

Cucujidae. *Laemophloeus ferrugineus* (Steph.). The Rusty Grain Beetle. Larvae, pupae, adults and frass (in Arabic *umeir*), in windfalls and in store. Serious pest. Cosmopolitan.

L. ater Oliv. In Libya (Martin, 1958).

Oryzaephilus mercator F. The Merchant Grain Beetle. Habits similar to *L. ferrugineus.* Serious pest. Cosmopolitan.

O. *surinamensis* L. The Saw-Toothed Grain Beetle. Habits similar to *L. ferrugineus.* Serious pest. Cosmopolitan.

Anobiidae. *Lasioderma serricorne* (F.) In stored dates. Unimportant.

Ptinidae (Spider Beetles). *Ptinus fur* L. In stored dates. Unimportant.

Tenebrionidae. *Tribolium confusam* Duv. Larvae, pupae, adults and frass in dates in store. Pest of medium importance. Cosmopolitan.

Scolytidae. *Coccotrypes dactyliperda* F. The Date-stone, or Button, Beetles. Attacks dates in the *khalaal* (hard, yellow, or red) stage on the palm and windfalls. Burrows into the pit. Causes dates to fall. Also provides entrance for fungus spores. North coast of Africa. Unimportant in the United States. In Lybia, serious. Also found on dates in Somalia.

Scarabaeidae (Chafers, etc.). *Cotinis texana* Casey. The Fig Beetle. Attacks dates on palm. Frass and adults found in the dates. Sometimes a serious pest. United States.

Hymenoptera (Ants, Bees, Wasps, etc.)

In the United States, honeybees, hornets and wasps damage dates (Stickney *et al.*, 1950).

Vespidae (Social Wasps). *Vespa orientalis* F. The Oriental Hornet. Enlarges holes in soft dates made by birds. A minor pest. Iraq, Israel.

Diptera

Trypetidae. *Ceratitis capitata* Wied. The Mediterranean fruit fly. Larvae in dates on palm. Unimportant. Israel.

ACARINA (Spiders, etc.)

Tetranychidae (Mites). *Oligonychus afrasiaticus* McGr. The Old World Date Mite.

Paratetranychus simplex Banks. The American Date Mite.

These minute spiders puncture the skin of green dates and spin a web over the whole bunch. Sahara (*bu farwa*); Libya, inland, not on coast, Martin, 1958 (*ghubaash, aghbaash, tadaghshiin, mughabasha*); Iraq (*ghubaar*). The dates develop a rough, hard, discolored skin and ripen imperfectly. Badly damaged dates are usually given to cattle and are not brought to the packing house, but slightly attacked dates may be mixed with sound ones and must be graded out. Serious and widespread pests, the former in the Old World and the latter in the New World.

Tyrophagidae. *Tyrophagus lintneri* Osborn. The Mushroom Mite. In stored dates. Important only in dates that have been stored a long time under unhygienic conditions. Contaminated dates can be detected by their unpleasant smell and unattractive appearance. They are unfit for human consumption.

The date grader may encounter dates damaged or infested by any of the above insects and spiders. He may also have to handle dates made unfit for human consumption by the presence of pupae of wasp-like predators of pyralids and of allied moths, a list of which is given below.

Hymenopterous parasites whose pupae may be found in dates infested by pyralids and allied moths:

Hymenoptera
Braconidae. *Bracon brevicornis* (Wesm.).
(= *Habrobracon kitcheneri* Dur. and Gough).
Microbracon hebetor Say. *Phanerotoma* sp.
Pteromalidae. *Neccatoloccus* sp.
Eulophidae. *Pediobius* (= *Pleurotropis*) sp.

Position of grading in chain of packing-house operations

If among the dates there are many culls, such as squashed, shrivelled, diseased, or infested dates, or if the dates are very diverse in respect of maturity, it is preferable that they should be graded before cleaning. It is a waste of washing or cleaning capacity to use it for culls. Dates in different stages of maturity need different cleaning treatments: but if, on the other hand, the dates in the parcel received on the packing floor are of good quality and at least moderately uniform, it is simpler to clean them before grading, so as not to have several lots to clean separately after grading is finished.

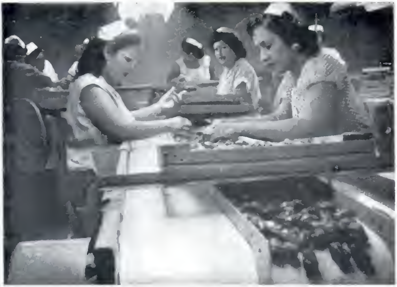

FIGURE 94. – Grading. California, United States.

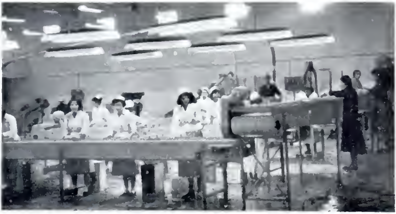

FIGURE 95. – Grading. Date Association Packing House, Baghdad, Iraq.

Most lots of dates are graded (Figures 94, 95 and 96) only once, but two gradings are common, one before processing, and one afterward. A grading belt (Figure 97) can also be inserted in any convenient place in the operations line before the packing tables (Figure 98), where dates can be given a final inspection and minor grading, to catch undesirable dates that have escaped the grading machines proper.

GRADING MACHINES

The term grading machine for dates is a misnomer, because it does not grade; it conveys dates in an efficient way to and from the human graders. A satisfactory mechanical grader for dates is not on the market. Dates do not lend themselves to grading by rolling along open-floored channels with sloping sides gradually separating more and more widely, such as are used for citrus, nor to grading by the counterbalanced trapdoor system. They are for the most part too sticky or too soft. The actual grading has to be done by hand. Grading machine, however, is a convenient term, understood in the trade.

The machine may consist of a dump elevator which raises the dates dumped onto it from boxes, carried by truck and manhandled, or from a conveyer belt, and of a three- (or four-) ply conveyer belt 40 to 60 centimeters wide, made of hard, heavy, white rubber, from 0.5 to 1 centimeter thick, with a highly polished surface (Figures 99, 100, 101, 102, 103 and 104). The belt, as in an ordinary belt conveyer, runs over two horizontal drums, of which the receiving-end one is loose and the delivery-end one drives. In between the drums are loose rollers supporting the belt both when it is forward-moving and when it returns. The distance between the two drums is adjustable to take up slack. The electric motor, of perhaps 0.5 horsepower, is provided with a variable-speed control. The machine can be of any length required, but one of about 5 meters is common.

Such a machine can be used either directly as a grading machine if the quantity of dates to be graded is small, when it would be provided with longitudinal wooden slats the length of the belt or, if the quantity of dates is large, then the machine can be used simply as a feeder, supplying, by means of shear arms projecting over the belt and of shoots, similar machines placed on one side, or on either side, and at right angles to it, at which the graders would sit.

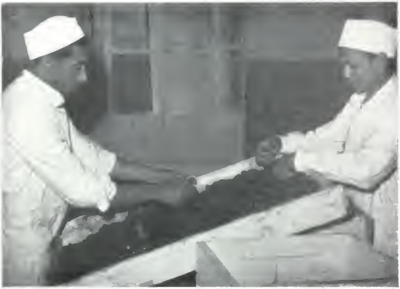

FIGURE 96. – Grading. Rural packing house, United Arab Republic.

Two removable, adjustable, longitudinal, wooden slats or dividers down the length of the belt would make three divisions (Figure 105). The central one is usually the widest and carries the dates to be sorted. If the grading girls sit only on one side of the belt, then the class of date to be removed which is present in the greatest amount would be put in the channel of medium width next to the girls. In the third and narrowest channel would be put that class of date which, of those classes whose removal is required, is present in the smaller quantity. In this way, the amount of stretching of the arm that the girls have to do is kept to a minimum. Of course, if the girls sit on both sides of the belt, then the one next to the narrowest channel will have to stretch more than the one opposite her. The dates that continue down the middle channel to the end of the belt would normally be the FAQ (Fair Average Quality) ones.

If a fancy pack is also required, then especially good dates could be picked out of the main lot and put either in one of the two lanes or in a box set beside each girl, or on a rack opposite her, if there is only one row of girls at the machine. If necessary, another box could be put on the other

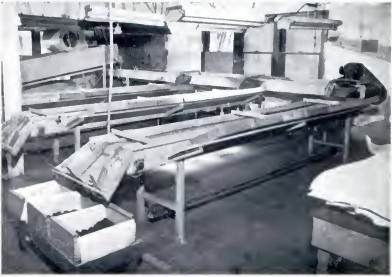

FIGURE 97. – Simplified washing and grading unit for small packing operations. Indio, California, United States.

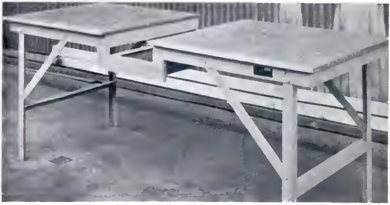

FIGURE 98. – Convenient packing table, Fresno, California, United States.

side of the girl for another quality to be separated. Sometimes another box, often for refuse, is put under the machine near the girls' feet. The two subsidiary lanes on the belt should be kept for the heaviest gradeouts, and boxes for the lightest, because the boxes have to be manhandled.

The dump-elevator belt should be of steel mesh to allow dirt and caps (perianths) to fall through into a refuse collector below.

There are two systems of grading from a moving belt: one, in which each girl removes all the grades of dates that have to be removed; and the other, in which each girl removes only one grade or, if the grades are many and the girls few, one, two, or three grades. The latter system is more efficient when there is enough of each grade to be removed to keep at least one girl busy, but less so if she is not kept busy.

The best girls should be at the bottom end of the belt so as to spot the oversights of the others. The head girl should be near the switch so that she can slow down or stop the machine if the dates are coming too fast to be graded properly. Naturally, if the machine which is stopped is fed by a

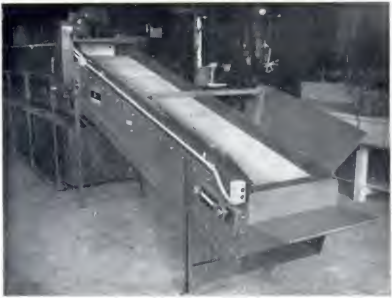

FIGURE 99. – Dump elevator in the manufacturers' workshop. Pomona, California, United States.

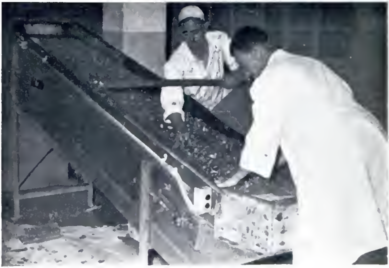

FIGURE 100. – The dump elevator in use at the Government Date-Packing House, Tripoli, Libya.

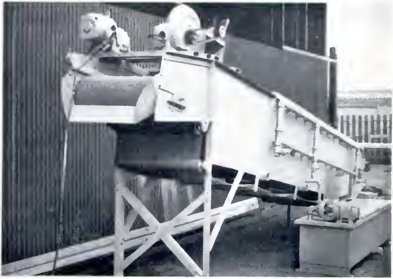

FIGURE 101. – Elevator and washer. Fresno, California, United States.

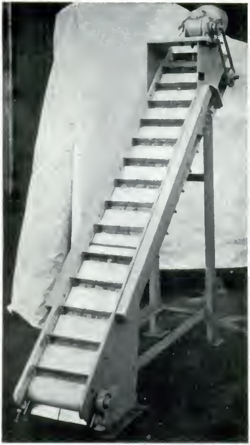

FIGURE 102. – Elevator for raising dates for packing, pressing, or for other purposes. Fresno, California, United States.

feeder machine, the speed of this may also need adjustment. If there are several grading belts depending on one feeder, removal belts under their delivery ends are necessary to take away for further treatment or storage the dates of the three classes into which the original dates are now separated.

Grading is important, but it is arduous, and it is expensive. It is, therefore, in the packer's interest to ensure that the girls are so accommodated that they can do the work as well, quickly, and as easily as possible. Girls will often stand, but they do so because their stools are uncomfor-

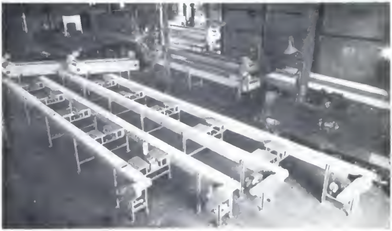

FIGURE 103. – General view of packing line for ten packers. Elevators, supply belts, date-packing and weighing tables, and removal belts in manufacturers' workshop. Pomona, California, United States.

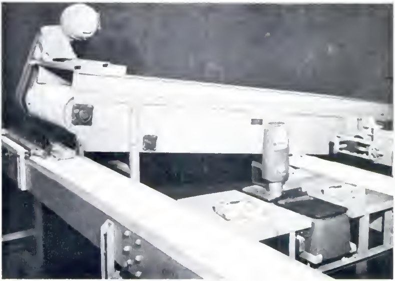

FIGURE 104. – Supply belts and packing and weighing table, showing scale conveniently let into table. Pomona, California, United States.

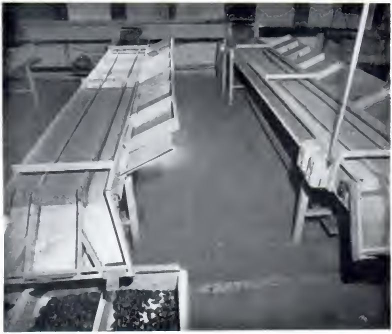

FIGURE 105. – Belt conveyor distributor, showing three divisions. Indio, California, United States.

table, because they are too low for the far side of the belt to be easily reached, or because they are perched too high on stools so that their backs ache with stooping. The chairs then should be comfortable and adjustable for height, so that each girl can put hers at such a height that she has a good view of the whole belt and can reach as far as necessary without undue strain. It is also worth while to let each girl, but not all the girls together, have a few minutes recess every hour and walk around, because, after too long a stretch of continuous work the girls sometimes become dizzy from watching intently the constant stream of dates passing in front of their eyes.

Good lighting (Figure 106) is necessary over the grading tables. The kind of artificial light which most nearly resembles daylight is to be preferred. The number of lumens employed should be the same as for a draftsman's drawing board. If there is a glare, the girls should wear eyeshades or peaked caps.

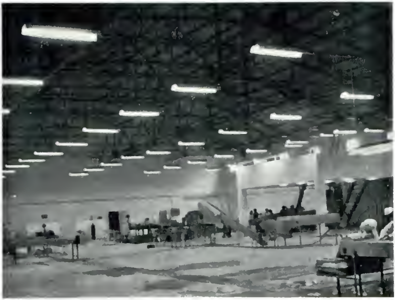

Figure 106. – Good lighting is necessary in a packing house. Date Association Packing House, Baghdad, Iraq.

GRADING FROM A MOVING BELT AND GRADING FROM A BOX ON A WIRE TRAY

Only a comparatively small part of the world's dates is graded from moving belts in the manner described in the previous section. A part is graded in the gardens, as described in the section " Field Grading. " Probably a considerably greater part is graded in the large number of temporary or permanent private packing stations that are found on both banks of the Shatt el-Arab in Iraq and Iran, where wire trays are commonly employed to hold the ungraded dates during grading.

In the early years of the present century, the girls used to sit on mats on the ground and to grade at the same time as they packed the cases. One box was in front of the girl, and into this the dates were packed. At her side was the box of ungraded dates as received from the gardens and from which she took the dates to pack. What was not suitable for packing she left untouched or put in another box on her other side. Sometimes the rejects all went into one box, but sometimes they were divided into, for example, soft dates, which went into one box, for subsequent sun drying, and dates which were undesirable for box packing and which would be basketed, which went into another.

A refinement, introduced in the early twenties, was that of a wire tray about a meter square, with wooden sides about 10 centimeters high, and supported about 10 centimeters above the ground by wooden legs at the corners. This tray allowed much of the dirt and small, red, June drop dates or the dates damaged by the larvae of the Lesser Date Moth to fall through the meshes to the ground, whence the day's accumulation was swept up in the evening.

Five or six years later, a further improvement was effected by the introduction of trays raised off the ground on trestles, at which the girls worked, sitting on stools, one on either side. These high trays, however, were for grading only, not merely, as were generally the low ones, for holding the dates from which the girls selected the good ones for packing.

In 1926, the first belt-grading machine was introduced in Basra (Figure 107), but it was not until 30 years later that a second one was imported, because, although the machine increased the output per grading girl, labor was so cheap, compared with that in California, that the capital cost of the machine made its use uneconomical. It is also to be remembered that the grading season on the Shatt el-Arab in Iraq and Iran lasts only from about 1 September to about 31 October, so that the machine has to pay for itself in two months of the year, while in California it is in use for three times as long. It is further to be remembered that most of the packing on the Shatt el-Arab is done in temporary packing houses on the river bank, not all of which are provided with electricity, while those which have electricity have not had it for long.

Grading from a clean, well-lighted travelling belt is, of course, cleaner and more efficient than grading on trays or boxes on the ground or even on trays raised off the ground on trestles, but in the old way responsibility for bad work was easier to fix on an individual than it is with team work on a belt.

With the shift from the export of unpitted dates in cases to that of pitted dates, which began in 1925 in Iraq, dates were generally graded first to speed up pitting. Later it was found more economical for both operations to be performed by the same girl, although, at least up to 1957, not all packers had changed the system. The usual operation nowadays, therefore, is for the girl to neglect refuse on the tray at which she is work-

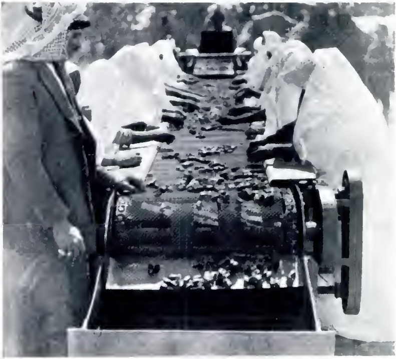

FIGURE 107. – The first mechanical grader to be used in Basra, Iraq. End 1926.

ing and to pit all passable dates, throwing the big ones into one box and the small ones into another. It may be added that it took 18 years before the whole export from Iraq in cases was pitted.

COST

The standard price for grading on the Shatt el-Arab in 1957 was I.D. (the equivalent of £ sterling) 0.088 (U.S. $0.2464) a quintal of graded dates.

Standards

Among the many changes in the period between the two world wars was the replacement, in retail sales, of the old system of shovelling food from bulk containers into paper bags by the new system of the small package, ready-wrapped, branded and standardized (Figures 108 and 109). The grocer's labor had become too expensive and the customer's time too valuable for the old hacking out of a lump of dates from a bulk box with a carving knife. The grocer wanted a ready-weighed packet he could hand to the customer without delay, and the latter wanted an easily recognizable one that he knew would contain dates just like those he was used to buying in the same kind of packet. The introduction of the branded packet of cheese, dates, sugar, tea, figs, meat or whatever it might be, whose contents would not vary in quality, led naturally to a demand by the distributors and wholesalers for their primary products to be already divided for them into definite, fixed grades by the producers and packers. That is to say, they wanted the products standardized. This demand became insistent with the onset of the depression in the early thirties, by which time the sellers' market of the war years had become a buyers' one, and producers all over the world found that they had quickly to adjust themselves to the new conditions or perish.

It was consequently about 1930 that date growers, date packers, date traders and their governments began to consider the standardization of grades as one of the ways for improving the condition of the date trade.

IRAQ

In Iraq, the Basra Date Board, a semigovernmental body, was set up. Lengthy discussions ensued concerning the advisability of establishing standard grades for dates, of establishing a grade inspection service, and of devising means to ensure that the grade mark on the box corresponded with the grade of dates inside. The matter was of great interest to all concerned with the trade, because, in a falling market, the consignee of the dates was apt to claim that the quality of the dates received was below specification.

The establishment of grades for dates and their enforcement proved, however, to be beyond the power of the board and of the association that took its place, although both bodies did excellent work in improving cleanliness and sanitation in the packing houses and in other respects.

Individual packers, nevertheless, especially when they were associated with repacking firms in Europe and America, did their best to pack to standards of their own devising. The repacker, especially, needed a date of a certain and constant size, shape, color and consistency for each kind of his small packs.

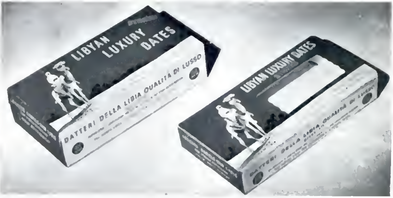
LIBYAN LUXURY DATES
DATTERI DELLA LIBIA QUALITÀ DI LUSSO
LIBYAN LUXURY DATES
DATTERI DELLA LIBIA QUALITÀ DI LUSSO

FIGURE 108. – Cartons (tops) closed (340 grams) and window (227 grams) designed for the Experimental Date-Packing House, Tripoli, Libya.

FIGURE 109. – Meccan dates in cartons for pilgrims, packed in modern, date-packing house set up temporarily by the government and FAO expert in Jedda, and transferred later to Mecca, are shown to FAO's then Director-General Mr. Norris E. Dodd and Dr. Ralph W. Philipps, former Deputy-Director of the Agriculture Division, Rome.

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The one Iraqi example of the prohibition of the export of a particular quality of date for other than sanitary reasons is that which occurred during the second world war, when the High Supply Committee in Baghdad prohibited the export of unpitted dates in order to save the 14 percent weight that the pits represented.

UNITED STATES OF AMERICA

The history of the standardization of grades for dates in the United States of America is instructive, because it shows how the date growers and packers were forced, by the pressure of increasing production and of increasing competition from other fruit, to adopt it. It also shows that it was the increasing production, as the palms grew taller, of the small, hard Daglat Nuur which actually first convinced the industry of the necessity of removing it, hydrated or not, from the straight date market. It could not, however, be dealt with separately under government orders until it had been legally defined. Here, then, was the first classification of dates into two grades by a government.

In April 1931, Gridley, Haywood and Marvin, in different papers presented at the Date Institute in Coachella Valley, California, had all advocated the adoption of standard grades. The first of these speakers introduced the matter in the following memorable passage.

> " Thus it appears that after having devoted the early years of its growth mainly to the solving of cultural difficulties the date industry now finds itself on the point of adding a brand new member to its already numerous family of problems – Marketing – bringing with it also some little brothers and sisters, one of which has quite a long name and is called The Development of Packing House Methods to Properly Handle Dates Under Quantity Production.
>
> " These latest star boarder acquisitions to the family of date grower's pet worries seem to have enormously healthy appetites and the task of curbing and bringing them under such control that they may not develop to undue proportions and cast the clouds of doubt, distrust and dismay over the industry is one that calls for all possible tact, patience and clear thinking at our command...
>
> " Before we proceed very much farther along the road leading towards the solution of our difficulties I would like to speak of something that has been growing right up in our path all along and which we

> have all very quietly and carefully stepped around in the hope that it might never become uncomfortably large. I am referring to the matter of the establishment of commercial grades for dates."

Two years later, the passing of the Agricultural Adjustment Act made marketing agreements possible; and, at the end of the year, an attempt was made to establish a pool for dry, substandard Daglat Nuur dates to divert them from being sold in competition with better quality dates of the same variety. The attempt failed because of inadequate financing, lack of co-operation among the growers, and lack of an adequate market for date by-products.

In 1935, the Agricultural Adjustment Act was amended so as to provide for marketing orders to regulate the handling of crops and to increase consumption through diversion to new outlets.

In September 1936, the date growers reached agreement among themselves, and then, on 22 October 1936, their representatives signed an agreement with the government, by the terms of which the representatives agreed to buy all dry, substandard Daglat Nuur from the growers at 7½ cents per pound, less ½ cent for administrative expenses, to maintain an inspection service (Figure 110), to market whole all they could before a certain date, and to sell the remainder before another fixed date for by-products, for date sugar (i. e., date powder) at 4 cents, for alcohol at 2 cents, and for stock feed at 1 cent per pound, the difference between buying and selling prices being made up by the government.

The following year, the Agricultural Adjustment Administration agreed to finance the diversion operation only on condition that the growers agreed to the diversion of all substandard dates being made compulsory.

Further progress toward reducing the competition of bad dates with good ones was made in 1938, when the California State Marketing Agreement was put into effect. This made it illegal to market substandard dates whole.

By 1943, the sale of all dates was controlled by a marketing order. A minimum grade was fixed, which specified the tolerance on fermentation, mold, decay, insect infestation, and bird pecks, but it was not until 1947 that other grades were added by law. The grades were amended in 1949 and again in 1955. This third issue of United States Standards for Grades of Dates is given as appendix 12. It will be noticed that the permissible grades are U.S. Fancy, U.S. Choice, U.S. Choice (Dry), U.S.

FIGURE 110. – The government inspector with his scales and records. California, United States.

Standard, U.S. Standard (Dry), Substandard. These grades differ from each other in the permitted proportion of defective dates and of dates of color different from that of the majority and in the degree of uniformity in size. It is interesting to note that no minimum size or weight for each grade is specified.

ALGERIA AND TUNISIA

The establishment of government grades for dates and of a government date inspection service in the United States was for the regulation of the internal market, for when they were introduced there was practically no external market. The other countries, however, where government standards are in force, introduced them in order to maintain or to improve their trade with foreign countries. Control in those countries has thus been exercised at the ports rather than in the packing houses.

In Tunisia, the decree of 5 October 1949 specifies the conditions under which dates may be exported, but it appears that, at least up to the 1951 season, they were not completely observed, for Secondi (1952) remarks that a large quantity of dates was not fumigated before export, although fumigation was supposed to be compulsory. The responsibility for the setting up of standards in Tunisia and for their enforcement rests with the Office tunisien de standardisation (OTUS). Daglat Nuur dates which come up to specification are permitted to use the export mark TUNISIA, and the less valued Aliig date (the Aliigh of the French literature) the mark OTUS.

The Algerian decree of 30 July 1949 lists the varieties of dates whose export is permitted, defines the grades for the Daglat Nuur variety, and specifies the sanitary requirements for dates prepared in packing houses for local sale. It is interesting to compare this with the American corresponding order and to note that here for the first time a government requires the date to conform to minimum weight standards. The Algerian decree has three grades for Daglat Nuur in retail packs: " Extra, " " Standard, " and " FAQ " (Fair Average Quality or *Marchande*). The weight of one date of the first must be not less than 7 grams and of the others not less than 6. Two grades of orchard-run dates for the repackers in Marseilles and Italy, which have received no packing house treatment, are allowed, one ungraded, with a minimum date weight of 6 grams, and the dry date (*frezza*) of 5 grams minimum. For further details see appendixes 13 and 14.

Cleaning

Dates are not easy to clean, yet it is desirable that they should be cleaned, because the public has become, or is becoming, conscious of the risks of eating dirt and spray residues. Apples, oranges, prunes, and other fruits, are nowadays washed in packing houses, although berries, for example, unless they are for canning, usually are not. If dates, like berries, were placed directly into pannets by the hand picker, there would be less need for washing but, as has been mentioned in the sections " Detaching the Dates, " " Lowering the Dates to the Ground, " and " Capping " (chapter 3), dates are not always handled carefully, and much of the crop entering the packing house has been at some time or other on the ground.

The apple is easy to clean by washing, because the fruit is large and firm and the skin is strong and shiny. Dates, on the other hand, are small, have usually a wrinkled skin, and may be soft and easily squashed.

Furthermore, they are expected by the public to keep indefinitely, whereas no housewife expects an apple to do so. Cleaning by washing, which may be expected to reduce a date's keeping quality, was therefore not much used in the early days of date packing in the United States of America. Instead, dry cleaning of some sort was generally employed.

It will have been observed that in the previous paragraph it was the cleaning practice of the United States of America that was referred to. The reason that this country was chosen for mention was because the other date-producing countries rarely practice cleaning, except in a very few private packing houses, and in the four or five packing houses on the American model that have been erected by governments in co-operation with FAO during the last few years.

In Algeria and Tunisia, the first quality Daglat Nuur for export are carefully handled during harvesting and are not allowed to touch the ground, and as they are also soft, they are not cleaned in the packing houses. The hard, dry Daglat Nuur for export are mostly soaked in water to hydrate them at their destinations, the packing houses of Marseilles and Italy, and thus receive a washing. With these exceptions, therefore, the cleaning of dates in packing houses is a practice that has been developed in the United States of America.

The dates of the American Southwest are frequently damaged by autumn rain and humid weather, so that in the early days of the industry, in the twenties, the dates were picked early and sold so soft that washing was avoided in order to lessen the risk of fermentation. Consequently, various dry-cleaning machines were devised, in which the dates were caused to flow down an inclined revolving towel-lined cylinder, where they were lightly brushed by fine, revolving brushes. One such machine was patented by Northrup before 1924, and others were made by growers and packers. It was found, however, that the brushes quickly became foul and needed constant replacement, so that the use of dry, damp, or wet towelling superseded that of brushes. The towelling also had to be changed frequently, but changing it was quicker and cheaper than replacing brushes.

THE SHAKER TRAY

The first cleaning operation is the shaking the dates receive on the shaker-tray feed (Figure 111). This is a sloping wire mesh tray, the lower end of which is pinioned to an eccentric, so that an up and down and a backward and forward movement are obtained. As the tray is on a slope, the dates which fall onto it at the top end are jerked forward little by little until they drop off at the lower end. On the journey, much of the looser dirt and debris fall through the meshes of the screen into a receptacle placed below. For quicker, smaller movements an electromagnet with interrupted current may be employed at the lower end of the tray instead of the eccentric. This as ordinarily used gives only an up and down move-

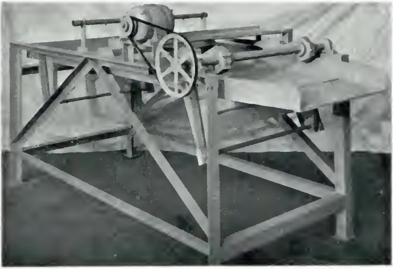

FIGURE 111. – Shaker cleaner. Fresno, California, United States.

ment, but, of course, the principle can be applied to produce a combination of movements in any direction.

This useful shaker tray can be considered both as an aid to grading and as one to cleaning. It can be inserted at any convenient part in the chain of packing-house operations, but it is between the elevator and the grading tables or between the elevator and the washing machine that it is usually found.

AIR CLEANING

After having had the dirt shaken off them, dates usually enter the washing machine (Figures 112, 113 and 114), but Brown, T. R. (1954), for his soft and crinkly Majhuul dates, has developed a system of cleaning by air blast (Figure 115) under a pressure of 5 kilograms per square centimeter, which he reports as satisfactory.

WASHING

Washing, however, is the ordinary way of cleaning dates nowadays. The washing machine consists of a wide, steel-link, travelling belt on a

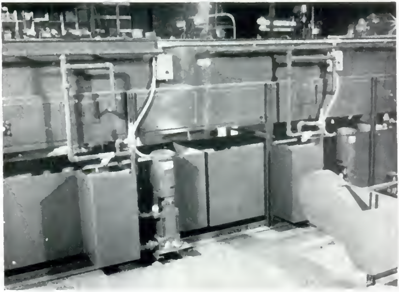

FIGURE 112. – Washing machine. Pomona, California, United States.

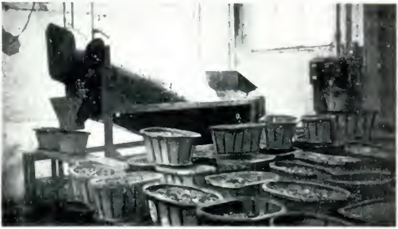

FIGURE 113. – Washing machine. Algeria. The dates are drained in chip baskets.

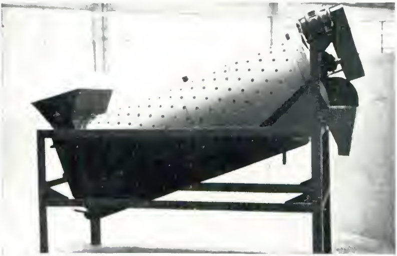

FIGURE 114. – Washing machine. Marseilles, France.

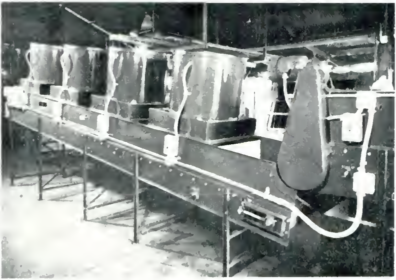

FIGURE 115. – Machine for drying dates by air blast after washing. Pomona, California, United States.

stand of convenient height and enclosed at the top, bottom and sides. Piping and spray nozzles are so arranged that sprays of water are directed onto the dates from many directions both from the top and from the bottom. The dates should be thinly spread on the belt, so that the spray can reach every part of them. Many fine sprays are more effective than a few coarse ones. The pressure used depends on the tenacity of the dirt to be removed and on the consistency of the date. Up to 15 kilograms per square centimeter has been used in Libya, but in California, with softer and much cleaner dates, the pressures employed probably do not exceed about a third of that, and the jets there are generally very small, in order to produce a mist rather than a douche.

Before entering the washer proper, the dates may be dropped onto an inclined plate of narrow, vertically arranged bars, so spaced as to allow shrivelled dates to fall through and normal dates to pass on. To help the passage of the shrivelled dates through the slots, jets of water play over them. In this way, some of the worst of the dirt is also removed before the dates enter the washer proper.

Detergents are commonly used in the first spray water, and a second batch of spray nozzles further along the washer is connected with a plain water supply for washing the detergent off the dates.

Even with water in well-directed sprays under a pressure of 15 kilograms per square centimeter, the Libyan, Bikraari pitted halves, dried in the sun on the ground in the gardens, could not be rid of all the sand that had adhered to the surface of the flesh, although, as Barreveld (1959) reports, the washing was so vigorous that 5 percent of the sugar of the date had been washed out in the process.

The reasons that caused the change in the United States from dry to wet cleaning, are its greater speed, its greater effectiveness, and the discovery of a method of preventing the souring that frequently resulted from the increase in the date moisture following washing. This method was the addition of 1 cubic centimeter of a solution of ethylene oxide or of a mixture of 15 percent ethylene oxide and 85 percent methyl formate (Rygg, 1958) to each pound carton of dates immediately before sealing (Figures 116 and 117). Ethylene oxide and methyl formate are fungicides and killers of the organisms causing fermentation; dates treated with them and packed in sealed cartons, although containing as much as 28 percent moisture, will remain sound at atmospheric temperatures for several months.

The washing machine quickly becomes dirty, so that it needs a thorough cleaning after every shift, not only to remove mechanically the ac-

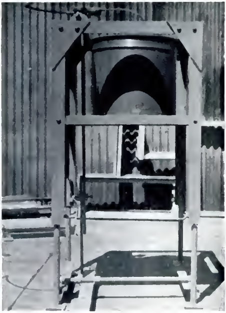

Figure 116. – Apparatus for automatic injection of small quantity of fungicide into each packet as it passes along conveyor belt. Fresno, California, United States.

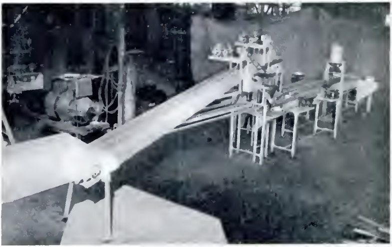

Figure 117. – Packing line, showing fumold injector and scales. Fresno, California, United States.

cumulation of dirt and bits of date, but also to remove the organisms that cause spoilage in soft dates. For this purpose, an ample supply of hot water under pressure is required, and a hose long enough to enable the stream of water to be directed to all parts of the machine and from any angle. A lance at the end of the hose, like a spray lance for fruit trees, permits better cleaning of holes and corners otherwise difficult to reach. The addition of a detergent to the hot water not only makes cleaning quicker but also aids the destruction of the organisms of decay. A small, portable, steam cleaner, kerosene fired, is very useful for the purpose.

DRYING AFTER WASHING

As dates during washing may pick up as much as 2 to 3 percent extra moisture, and Bikraari sun-dried halves even 5 percent or more (Barreveld, 1959), some drying is usually necessary after the process, except on dry dates. In 1955 an experiment showed that Bikraari, sun-dried, pitted halves, when weighed directly after passing through the washing machine, were found to have gained 6 percent in weight. The actual amount of water added was, of course, greater than this by the weight of dirt and sugar removed.

In Algeria and Tunisia, after the dry dates have been soaked, they are put on wire-bottomed trays in a stack, and a large fan in a box frame on wheels is set right up against it to blow a powerful draft over the dates to dry off the superfluous water. R. H. Postlethwaite (Russel, R., 1924) devised a machine for heating the air before driving it over the dates on a steel-link belt running through a tunnel after they had passed out of the washer, and this procedure is still employed. A strong blast of hot air is desirable for dates that are to go straight from washing to packing, but if the dates are dry and would be improved by the addition of moisture, then they can be left to dry slowly on trays stacked in racks. Also, if the dates after washing are destined for dehydration in a dehydrator that dries them rapidly, it may not be worth investing in an expensive preliminary dryer. Also, of course, if the washed dates are to be hydrated, no drying is necessary.

Pitting

The dessert date is generally expected to contain a pit, unless it is in a fancy pack and stuffed with a nut in place of the pit, but the date for cooking and for the baker and confectioner has to be pitted. The housewife can no longer be bothered to pit the dates before she makes a date pudding, and the baker and confectioner are of the same mind. Unfortunately, however, there is no method of pitting which can be depended upon to give a quantity of pitted dates with never a pit among them. Yet one pit in a few hundred dates may be enough to break a confectioner's machine or a customer's tooth. If the package from which the customer took the date is labelled " Pitted, " he may claim from the packers, generally successfully, 50 or even 100 dollars in compensation.

HAND PITTING

The method of pitting which, up to the present, gives the lowest proportion of pits left by mistake among the pitted dates is hand pitting, but even here very careful checking is necessary. It has been suggested that the detection of pits in dates supposed to have been pitted could be effected by means of X-rays, but the idea does not appear to have been developed.

The date is held in the left hand and a short-bladed pitting knife in the right. A longitudinal cut is made in the date, the pit is extracted with the point of the knife, the white skin round the pit is tucked back so that it does not show outside the date, and then the two edges of the date are neatly pressed together, so that, until one pinches it, one can hardly tell whether the date has been pitted or not.

The disadvantage of hand pitting in the United States is its high cost, for a girl pits only from 25 to 50 kilograms (pitted weight) of dates a day. Hand pitting of a larger fruit is quicker. For example, a girl can pit 250 kilograms (pitted weight) of peaches in an eight-hour shift. Hand pitting cost £ 3.30 (U.S. $ 9.24) a ton in Basra in 1957 and £ 5 to £ 10 (U.S. $ 14.00 to 28.00) a ton today (1960) in Libya (though here there is no way of putting the date back into shape after the extraction of the pit, as in Iraq), but in the United States the cost is, of course, very much higher, so that, for at least 30 years past, efforts have been made to devise mechanical pitters.

HAND-OPERATED DATE PITTER [1]

A household pitting device, originally intended for pitting cherries, apricots, plums, etc., has been adapted by FAO experts working in Libya for pitting dates. It has the great advantage that, with proper arrangement of the device and receptacle for pitted dates, the possibility of pits slipping into the finished dates is nonexistent. Figure 118 shows basic details of this device. It consists essentially of a small cup (D), in the base of which slides a replaceable perforated rubber diaphragm. Above the cup is mounted a spring-loaded plunger (A), the end of which (C) consists of a claw-like device to prevent the stone from slipping sideways once pressure is applied. The claw end of the plunger is directed through the date and into the perforated diaphragm by means of two guides which form part of the cast alloy form of the device. It can be conveniently fixed to any bench or table by means of a thumbscrew at the bottom of the machine. In order to prevent the plunger (A) from sticking in the two guides, owing to the adherence of sugar, a small cylinder (B) is fitted which contains a plastic foam cushion impregnated with pharmaceutical paraffin or vaseline oil, the latter dissolving the thin film of sugar syrup collecting on the plunger while passing through the date.

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[1] Text prepared by W. H. Barreveld and S. L. Galpin.

The date is placed upright, calyx downward, in the cup; the plunger is pressed by a gentle hand pressure, and goes into the date and pushes the pit; thereby it moves the calyx and claw end of the plunger through the perforated rubber diaphragm, diverting the calyx and pit by means of chute (E). Pressure is released and the plunger returns to the raised position, the diaphragm preventing either pit or calyx from returning into the date. Figures 118A to 118C illustrate the operation.

No extensive training is required for operating the pitters, and when properly used, several advantages are obtained over the hand-pitting method, as follows:

1. A great outturn, because an average of 1,000 dates per hour is easily obtained, equal to 7 kilograms of pitted dates.

2. The date remains whole and is neither cut open nor in half.

3. The cylindrical hole through the date made by the plunger allows for easier and more thorough pasteurization and steaming (the dates should be pasteurized *after*, and not *before*, pitting).

4. Since the dates are hollow, they can be easily stuffed afterward, and most important, neither pit nor calyx can be accidentally left in the date nor mixed up with the pitted dates.

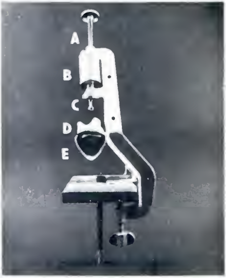

FIGURE 118. – Details of a hand-operated date pitter, front view.

A. Spring-loaded plunger. B. Cylinder containing a plastic-foam cushion impregnated with pharmaceutical paraffin or vaseline oil. C. Claw-like device. D. Cup. E. Chute.

(Courtesy W. H. Barreveld and S. L. Galpin)

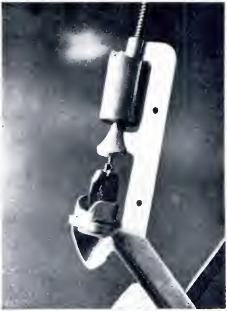

FIGURE 118 A. – Hand-operated date pitter from Figure 118 in operation. Plunger with claw just entering the date.

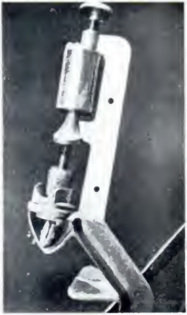

Figure 118 B. – Hand-operated date pitter from Figure 118 in operation. The date pit and calyx are pushed out.

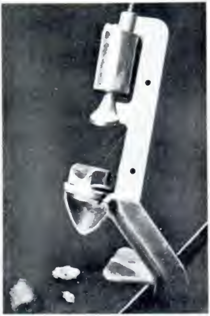

Figure 118 C. – Hand-operated date pitter from Figure 118 after the operation. Pit and calyx are separated from the date flesh.

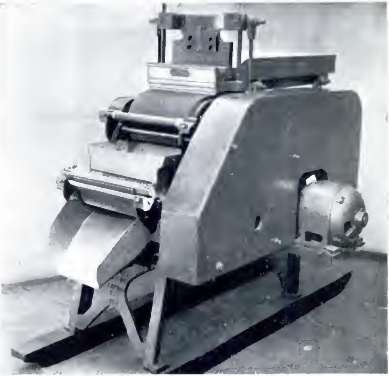

FIGURE 119. – The California masher pitter. Fresno, California, United States.

THE MASHER PITTER

One pitter (Figure 119) has been developed from the well-known raisin pitter of California, the essential feature of which is two rollers of equal length and diameter, set so that they touch each other. One is of steel covered with soft rubber, and the other consists of notched circular steel disks, separated from each other by washers about 0.5 centimeter wide. The rollers turn toward each other and the dates are caused to drop between them. The dates are thus so tightly squeezed between the two rollers that they are pressed out flat. The pits, being wider than the spaces between the steel disks, are pressed into the rubber and fall directly downward into a chute, but the flesh becomes entangled in the serrations in the edges, of

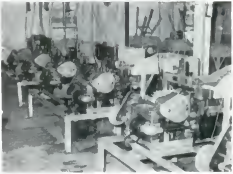

FIGURE 120. – Battery of plunger-type date pitters. California, United States.

and between the disks, and is carried on the disks for half a revolution until it encounters scrapers, which cause it to fall into a second chute.

This machine, not being constructed of stainless steel, causes very soft dates to darken, for when the cells are crushed, their contained tannin comes into contact with the iron. It is also not suitable for hard dates, nor for soft dates, but it works satisfactorily with dates in a narrow range of medium moisture content. The dates, of course, having been mashed, lose their identity, so that they can be used only for by-products.

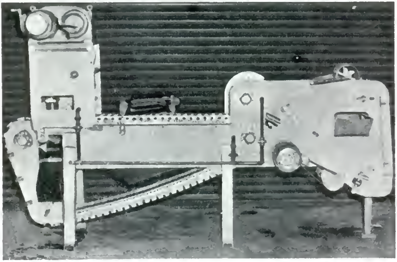

FIGURE 121. – Semiautomatic pitter. California, United States.

THE WHOLE DATE PITTERS

Two other pitters (Figures 120 and 121) which are manufactured in the United States are designed to preserve the shape and appearance of the date. The essential feature of these machines is the gripping of each date singly in a slot in the circumference of a revolving steel wheel, and the subsequent ejection of the pit at one end of the date by means of a steel plunger which pushes through the other end. One of these machines has to have the dates fed by hand into the slots, but in the other the whole operation is mechanical. Both require the dates fed to them to be carefully graded for size, and in both the plunger sometimes misses a pit or chips a bit off it. They also need the constant attention of a good mechanic. However, when one considers how many difficulties in the preparation of food products by mechanical means have been overcome, it is to be expected that improvements will continue to be made in date-pitting machines, which will eventually make them even more reliable than hand pitting.

THE STICKINESS OF DATES

One of the difficulties in the mechanical handling of dates has always been their stickiness; but Schiller and Maier (1959) point out that this undesirable quality can be removed by spraying the dates with, or immersing them in, a 6 percent aqueous solution of cold water-soluble starch or a 3 percent solution of methyl cellulose. Possibly with the use of these materials, or in other ways, dates can be made more free-flowing and so more adaptable for handling by machines. In this connection, it may be observed that the cherry, which is free-flowing, gives little trouble in the cherry pitter, a machine in which the cherries roll into small cups, held there, and speared with a cross-shaped plunger.

Stickiness can also be counteracted by the use of finely powdered corn (maize) starch. This material is largely used in the sliced (diced) date trade of Basra (Iraq) and Khurramshahr (Iran).

5. PROCESSING

Date processing is not new; it must have been practiced since the earliest times of date cultivation. The same could be said of the processing of the fig, the apricot and the grape.

The processing of dates is the treatment given them after harvest which changes their composition, color, shape, size or texture, and which results in a marketable product that is still essentially dates or date flesh. The maceration of dates in water and the distillation of alcohol from the mash by this definition would not be processing; it would be the manufacture of a by-product.

The following are considered to be processing operations: drying, hydrating (addition of moisture), heating, freezing, preserving by chemical means, coloring, pressing, grinding.

The purposes of processing are (*a*) to hasten ripening; (*b*) to ripen dates that would not ripen properly if left on the palm; (*c*) to make long-keeping products out of *khalaal;* (*d*) to make possible the selling of *rutab* or soft *tamar* on a distant market; (*e*) to soften hard dates; (*f*) to improve the appearance, texture and keeping quality of *tamar;* and (*g*) to destroy molds, yeasts, bacteria, etc., and insects.

In the marginal producing districts, artificial means of ripening have to be used, but even in Iraq, where the enormous crop ripens perfectly upon the palm, most of it is subjected to pressure during packing and to that extent can be considered to be processed.

Regions of different processing methods

It is possible that in the previous part of this text the preponderance of references to American literature, with its special preoccupation with the Daglat Nuur date, has given an erroneous conception of the world's date industry and its difficulties. Conditions in different parts of the date-growing world, however, vary widely. Broadly and briefly, date growing may be said to be important in six districts with four climates and with four kinds of processing and packing techniques. The districts are:

IRAQ

Iraq and neighboring lands, with just the right climate to cure dates fully on the palm and almost all producing invert, soft dates. The dates are not dried after harvest but are pressed straight into boxes or baskets.

SOUTHERN TUNISIA AND NORTHERN SAHARA

Climatic conditions are similar to those in Iraq and neighboring lands and for the most part the dates are of the soft invert type, which are packed into baskets and skins, or plaster stores, as soon as they are harvested. This region also produces the Daglat Nuur date. Those French growers and French companies that have engaged in date farming have all confined themselves to the production of this variety, and the greater part of the literature on dates published in this region (and in France) has had the Daglat Nuur as its subject.

The processing of this date is an extensive industry.

UNITED STATES

The United States is the only country in the world where the Daglat Nuur predominates over the other varieties. The climate approaches the marginal, and the technique of processing is more highly developed than anywhere else. (The Salt River Valley, Arizona, and several other places in the American Southwest, are marginal for dates, that is, most years the heat is too little, the rain too early, or the humidity too great.)

THE SUDAN, THE SOUTH OF THE UNITED ARAB REPUBLIC AND SOUTHERN LIBYA

The great heat and the very dry air produce a hard, dry date. The dates are left hanging on the palms for a month or two, after they have reached what would be considered elsewhere to be the fully cured *tamar* stage, and are then packed in sacks or stored in sand pits.

THE NORTH OF THE UNITED ARAB REPUBLIC AND NORTHERN LIBYA

A climate not hot enough to produce fully ripe dates on the palm and producing almost all invert, *rutab* dates. After harvest, dates need to be dried in the sun before packing.

Much of the crop is consumed fresh.

THE SHORES OF SOUTHERN ARABIA AND THE PERSIAN GULF

The climate is very hot but very humid. Many of the dates fall from the palms before reaching the *tamar* stage, and sun drying is practiced.

Heat

DEFINITION

Heat is normally applied to dates in the course of the following processes:

Maturation; Curing; Drying; Dehydration; Pasteurization; Sterilization; Hydration with hot water; Hydration with steam.

In the Section " Field Ripening and Curing " (chapter 3), it was suggested that ripening and maturation meant much the same thing, but that the former was perhaps the better word for the field process, and that maturation might be left for the same process in the packing house. Roughly, both terms apply to the transformation of *khalaal* into *rutab*. Curing, the continuation of the process, is the transformation of *rutab* into *tamar;* and the term is used for both the field and packing-house processes. The distinction between the two processes tends to be blurred, however, by the difference between the state in which the Daglat Nuur and that in which most of the other commercial varieties are marketed. The Daglat Nuur is generally sold as *rutab* just on the turn to *tamar*, while the others are generally sold in the firmer *tamar* stage.

It was also stated that drying may well be considered the field term for the dehydration of the packing house. However, drying in the packing house is the term generally employed for the dissipation of the washing water that adheres to the outside of the dates, as mentioned in the section " Drying after Washing " (chapter 4). Dehydration in the packing house and drying in the field connote more the removal of moisture from the inside of the date.

Sterilization is a term sometimes used in date literature, but in practice no dates are sterilized. To make a substance sterile, that is, to kill in it not only all micro-organisms in their vegetative stages but also all their spores, a temperature of 150° C. in dry air maintained for three hours would be required, or of 170° C. for one hour or, for a liquid, 100° C. for one and a half hours under a pressure of two atmospheres.

Hydration will be discussed in a later section. Meanwhile, it is to be noted that when it is effected with hot water or steam, the dates are affected by the heat as well as by hydration (intake of water).

HISTORICAL

The cooking and smoking of food are the commonest and oldest instances of its preservation by heat treatment, but Appert in 1810 seems to have been the first to consider the commercial use of artificial heat as opposed to smoking for the preservation of foodstuffs. The drying of fresh fruits in the sun is a practice of great antiquity, but their artificial drying by the application of controlled heat in packing houses was very little practiced before the first world war. It was, however, as early as 1907 that Vinson in Arizona began experiments in the treatment of dates by artificial heat. The practice spread to all the American date-packing houses; it was not until the second world war, which gave a great impetus to the drying of fruit and vegetables, that American fruit growers generally became interested in the principles and technique of fruit dehydration and in the equipment for it.

ADVANTAGES

The advantages of artificial drying over sun drying are that it enables fruit to be matured and therefore saved from rotting when the weather is cloudy and wet: it is quicker than sun drying and therefore effects an economy in the use of drying trays and allows the fruit to reach the early market; it is cleaner than sun drying; it avoids insect infestation of the drying dates; and it economizes space. It also enables a better control of the final moisture content of the dried product.

Heat treatment, if the temperature is high enough, also kills insect pests and their eggs in dates. Goodwin (1914) states that two hours at 55° C. kill all insects in grain. Shafik and Hilmy (1939) state that two hours at 60° C. kill all stages of *Ephestia* sp. and *Myelois* sp. in dates.

The effect of heat, however, depends on the relative humidity (R.H.) of the air. Thus Lindgren and Vincent (1953) state that 93 percent of some of the Nitidulid beetles that attack dates were killed at 39° C. on an exposure of 20 minutes at 10 percent R.H., 11 minutes at 50 percent R.H., and 10 minutes at 90 percent R.H.

The dryness of the air can be expressed in figures, and the unit usually adopted is the " Percentage Relative Humidity " (% R.H.). This is the amount of moisture in the air at any given temperature expressed as the percentage of the amount of water it would contain if it were fully saturated at that temperature.

Humidity in the air is usually found by noting the difference between the reading of a wet bulb and that of a dry bulb thermometer, and then referring to those tables or graphs which show humidity expressed as a percentage for every degree (or fraction of a degree) of difference at every degree (or fraction of a degree) of dry bulb temperature. When the readings of both thermometers are the same, the air is saturated, that is, its relative humidity is 100 percent. The greater the difference between the two readings for any given dry bulb temperature, the less is the relative humidity.

The greater temperatures found necessary by Goodwin and by Shafik and Hilmy were presumably due to the fact that they were dealing with bulk products, and there was, no doubt, a long time-temperature lag between the temperature on the outside of the mass and that inside. Lindgren and Vincent, on the other hand, were observing the behavior of the beetles exposed in glass-tubing cages.

Fellers, C.R. (private communication, 1925) states that all insect life in a carton of dates is killed by 50 minutes at 77° C. at a relative humidity of 75 percent.

Artificial maturation is not only often preferable to sun drying, but it is frequently preferable to the ordinary maturation on the palm because, whereas there may elapse a period of as much as six weeks between the maturation of the first date and the last date on the bunch, with artificial heat the ripening is quicker and more even.

Uses

Heat hastens the ripening process, provided ripening has proceeded naturally, that is to say, on the palm, up to a certain point. Below that certain point no heat treatment is of any use. The certain point is, presumably, that at which, after the great influx of sugar into the date that occurs shortly before ripening (Vinson, 1924), a starter or an enzyme is released. After that point, although the date has been severed from the palm, ripening can proceed normally, provided there is the required temperature and humidity. The certain point precedes by a few days the appearance of the first, small darkening, soft spot, generally at the apex of the date, the beginning of the change from the hard, shiny, brightly colored *khalaal* to the soft, more or less wrinkled, duller *rutab*. When the spot appears, artificial ripening (maturation) can proceed without difficulty but dates gathered before the spot appears can also be ripened artificially. There is, however, nothing to show externally whether they are capable of being ripened or not. The usual practice with the Daglat Nuur, the commonest variety to be ripened artificially, is for the bunch to be cut when most of its dates show the apical spot. Most of the other dates will also ripen. Those that do not are thrown out as culls.

With reference to the remark above that ripening starts with the release of a starter or enzyme, the statement of Vinson (1924) may be quoted, i.e.; " Ripening appears to be the result of the release of previously insoluble intracellular enzymes, and may be accelerated by the application of moderate heat, " but he adds that the mature sucrose dates have no ' notable quantities of extracellular invertase. ' However, whatever may be the enzymes and their way of working in the two classes of dates, it is certain that heat permits or hastens the conversion of the starch in the date to sucrose, the conversion of sucrose to reducing sugars, the precipitation of tannin in an insoluble form, the softening of the flesh and of the rag (which disappears last from round the base of the seed), that is to say, the conversion of cellulose to sugar, the darkening of the color of the flesh and skin and, if still continued, the drying out of the date, and finally, if of sufficient intensity, the caramelization of the sugar.

Broadly speaking, the higher the temperature of the heat treatment given to the dates, the shorter is the time required but the greater is the degree of darkening. The darkening of most dates on maturation is not considered a drawback by the consumers of most of the world's date varieties, but the Daglat Nuur, when well ripened on the palm to a late *rutab* stage is of such a lovely, translucent, pale, amber color, that once the consumer has eaten this date in this condition, any darkening by too rapid, artificial maturation displeases him and reduces his willingness to pay a high price for this variety.

Maier and Schiller (1959) state that the darkening of the color of

Daglat Nuur dates of 19.1 percent moisture content at 49° C. (120° F.) is mainly a nonoxidative and nonenzymic process, but one which is probably caused by carbonyl-amine browning and is only partly enzymic, probably a result of polyphenolase activity.

Finally, heat treatment, by killing fungi and bacteria, and by reducing the moisture content of the dates, stops and prevents fermentation, souring, the growth of mold, and decay. It prevents sugar spotting, and it can be used to bring the syrup to the surface and to give a gloss.

TRAYS

As West *et al.* (1952) point out, mild steel is unsuitable for fruit trays used for dehydration, and stainless steel and monel metal are too costly. Wooden frames with galvanized wire bottoms are used, but all-wooden trays are better, because the dates stick to the slatted bottom less tenaciously than they do to the wire.

For a big dehydrator, trays 2 meters × 1 meter are convenient, but trays of only a quarter that size are necessary if one man alone is to handle them. A tray of 170 × 75 centimeters is used in Algeria.

The loading rate for apples or cherries (West, 1952) is 9.8 kilograms per square meter, but for Bikraari halves in Libya 8 kilograms per square meter was found to be about the loading limit.

The dates stick to the trays after dehydration. The best way of removing them is by means of a sharp-edged paddle of hard wood while the trays are held in a rack, resting on their side over a chute, which catches the dates as they fall off the trays, and through which they fall to a box below (Figure 122).

Trays need a good scraping and washing from time to time (Figure 123). They should be thoroughly washed and scalded at the end of the season, and stacked in the shade in a dry and ventilated place.

Mechanical tray stackers save labor and take up little space, but they would pay for themselves only if a large quantity of dates has to be dehydrated.

MATURATION

As has been mentioned before, all the dates on the bunch do not ripen at the same time. However, in a place like Basra, where the temperature at harvest is very high, the time lag between the ripening of the first date on the bunch and the last one is short, and the first date does not

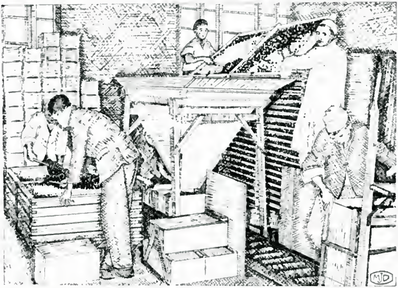

FIGURE 122. – Unloading of trays on which dates have been dehydrated. Government Date-Packing House, Tripoli, Libya.

(Courtesy Mrs. Joy Dowson)

dry out excessively before the last one is ripe, so that the whole bunch can be cut at one time. The Daglat Nuur of Algeria and of Tunisia, however, ripens more unevenly and over a longer period. This date is also required by the packer to be in a softish, nearly ripe stage. It is, therefore, more convenient for the bunch to be cut when most of the dates have begun to soften and for maturation to be continued in sheds, where the bunches can be gone over at frequent intervals and the dates fit for packing picked off.

The sheds are attached to the packing houses and in them the bunches are suspended from hooks hanging on poles set horizontally one above the other and 1 meter apart. These *penderies* shelter the dates from rain, allow air to circulate, and in them the dates just on the turn from *khalaal* to *rutab*, with 35 to 40 percent moisture, ripen fully to a soft *tamar* in a few weeks, while the *rutab* (*murattab*), with 25 to 28 percent moisture, ripen in a few days. Even with this seminatural way of ripening, many of the Daglat Nuur dates fail to maintain their pale color and have to be consigned to a second-class pack.

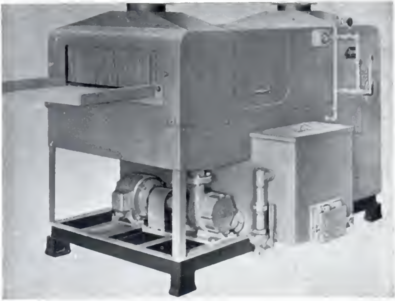

FIGURE 123. – Tray washer; can wash and rinse up to 100 trays an hour. Gomersal, England.

In Arizona and California, because of the less favorable climate, with the possibility of the early advent of humid weather, and with higher labor costs, maturation is mostly by artificial heat, though in the early days of the industry there was some maturation at atmospheric temperature, either in special chambers, provided with fans to circulate the air, or in the sun on trays covered with cheesecloth to keep away insects.

For Daglat Nuur dates, in order to preserve their light color, maturation should not be at a temperature higher than 35° C. (95° F.), but most other varieties can stand up to 49° C. (120° F.). Generally speaking, the lower the temperature (but always above that of the atmosphere, of course) the better the dates mature, but they take longer to do so. Furthermore, if the dates contain much moisture, say 50 percent, and if the ripening process takes too long, they may ferment before they ripen.

Table 26 summarizes the temperature recommendations of a number of workers for the artificial maturation of dates. They are in general agreement, but it will be noted that Drummond (1924) and Tate (1958)

TABLE 26. – Summary of temperatures recommended by various authorities for the artificial maturation of dates

Year	Authority	°C. (°F. in brackets)	Percentage relative humidity	Period	Remarks
1911	Freeman	Up to 49 (120)			This high temperature made the dates syrupy
1924	Drummond	21-32 (70-90) 32-41 (90-105)		About 5 days	For less mature dates For more mature dates Lower temperature and longer time best
1924	Swingle	29 (85)			With air previously dried by refrigeration
1927	Fattah	54 (130) 49 (120)		2 days 1½ days	Barhi dates (darkened) Barhi dates (less dark)
1927	Fattah and Cruess	49 (120)			
1930	Postlethwaite	32 (90)	50	7 days	
1930	Sievers	32-35 (90-95)	25-35	Few days	75-78 % relative humidity gives good maturation but does not allow dates to dry down enough
1935	Albert	35-43 (95-110)	60-80		Dates reach 25-27 % moisture
1938	Postlethwaite	37 (98)	46	4 days	
1954	Monciero	40 (104)			After freezing
1958	Tate	34-41 (95-105) 41-46 (105-115) 46-49 (115-120) Up to 54 (130)		3-4 days 2-3 days 1-2 days or few hours or not at all	⅓ translucent Translucent Tree ripe Fruit with high moisture content after rain
1958	Rygg	35-38 (95-100) 35-46 (95-115)			Daglat Nuur Soft varieties
1959	Nixon	27-49 (80-120) Higher 35 (95)	Higher	Several hours to several days	For more mature fruit For less mature fruit Should not be exceeded for Daglat Nuur

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recommend a higher temperature for the more mature dates, while Nixon (1959) recommends a lower one.

The recommended relative humidity varies from 25 to 80 percent. In general, a high humidity gives a better ripening than a low one, but it may leave the date with more water in it than is required.

From the work so far done on the maturation of dates, it is not possible to compile a statement showing the best temperature and the best humidity, for each of the main varieties normally artificially matured, at different stages of maturity and at different water contents. The best advice that can be offered to the prospective date processer is to equip his maturation chambers in such a way that he can vary temperature and humidity at will, and can experiment.

CURING

It has been suggested that maturation was a good word for the ripening in the packing house of the *khalaal* or of the half *rutab* into the full *rutab* stage, and that curing was the later stage of turning the *rutab*, the botanically ripe, the commercially ripe, as it would be considered in California; in other words, the fresh fruit, into the *tamar*, the long-keeping or preserved date. Curing is the continuation of maturation.

There is not much curing in the packing houses, because the Daglat Nuur is required in the late *rutab* stage and most of the other varieties reach the packing house as *tamar*. Such curing as there is will be considered later in the section " Dehydration. "

PASTEURIZATION

Maturation has as its object the helping of the processes which turn the date from an unripe into a ripe fruit. Dehydration has as its object the removal of surplus moisture, pasteurization that of killing the organisms of fermentation, decay and disease, and the destruction of enzymes that bring about the physiological changes which gradually cause deterioration.

Pasteurization is the process of subjecting food and other material to a temperature of 70° C. for 20 minutes, or to a slightly higher temperature for a slightly shorter period. Of course, all parts of the food treated have to attain this temperature. All yeasts, other fungi and bacteria in their vegetative condition, and many but not all spores are killed. The pathogens of the common intestinal diseases are killed.

From the observed results, however, there would seem to be a doubt as to whether such treatment does indeed destroy all enzymes in dates and all the organisms of decay on them, at least in and on dates with a high moisture content. Thus Hilgeman and Smith (1938) found that Haiyaani dates at 43-47 percent moisture became moldy after pasteurization at from two to four hours at 70° C. (158° F.), while those whose moisture content was only 39 percent did not. There is, however, a doubt here: it may be that the dates were reinfected after pasteurization.

Hunwicke and Grinling (1928) traced an outbreak of severe colitis to packaged dates from Algeria or Tunisia, presumably Daglat Nuur, and not pressed together in a block. Clague and Fellers (1933) in America isolated coliform bacteria from 6 out of 11 packets of dates. They did not find such bacteria in bulk dates, that is, in the Iraqi dates imported in a tightly pressed and sticky condition in the 33-kilogram wooden cases. These last two workers, using *B. coli* as an indicator of pasteurization efficiency, and working with imported Iraqi dates having a water content not exceeding 20 percent, found that the following treatments killed all *B. coli* on them:

Minutes	Temperature		Percentage relative humidity
	°C.	°F.	
20	87	188	96
30	82	179	75
40	77	170	69
50	71	160	90
60	66	150	100
80 +	63	145	?

Fellers, in a private communication, states that with packaged dates of a water content not exceeding 20 percent, and with an initial temperature of not less that 18° C. (65° F.), the best pasteurizing treatment is at least 50 minutes at a temperature of 77° C. (170° F.) and a relative humidity of 75 percent or slightly more. During the process the dates pick up about 2 percent moisture.

While dryish *tamar*, already dark in color, can stand such an elevated temperature for so long a period, the light-colored Daglat Nuur with its high sucrose content cannot do so. Fortunately for the packer, the comparatively recent adoption of the use of the fungicide, the methyl formate-ethylene oxide mixture, has to a considerable extent made pasteurization unnecessary. Rygg (1958) mentions that pasteurization has been employed more in Arizona than in California. That this is so is presumably due to the greater humidity of the atmosphere in the first state than in the second.

Reed in 1924 advocated the pasteurization of dates at 74° C. (165° F.). He found they would stand 79° C. (175° F.) without having their flavor spoiled, but that at above that temperature they acquired a slightly cooked taste. They caramelized at 88° C. (190° F.). He does not state the variety of the dates with which he was dealing. It may have been Zahdi. It is doubtful whether American packers (as distinct from the American repackers of Iraqi dates) today would use such high temperatures for pasteurization, and it is certain they would not use them for the Daglat Nuur. Reed does not state for how long he kept the dates at these temperatures, but probably not for long. A disadvantage in heating dates to a high temperature for a short time, especially at a low relative humidity, instead of to a lower temperature for a longer time, is that they have a tendency to case-harden, that is, the skin and outer part of the flesh dries, perhaps is killed, and becomes relatively impermeable to the passage of water, so that the moisture nearer the center cannot escape and the date remains soft inside.

In the same Date Growers' Institute report as that which contains an account of Reed's address, that is, the first report in 1924, there is a contribution by Goar, who stated that his own pasteurization temperature varied from 49° C. (120° F.) to 66° C. (150° F.), and added that few varieties could stand more than 54° C. (130° F.) for more than 30 minutes.

Swann, in the same report, recommended 66° C. (150° F.) to 71° C. (160° F.) to be reached slowly and maintained for 30 minutes.

Swingle, W.T., also in the same report, advocated 71° C. (160° F.) to 77° C. (170° F.), but for varieties other than Daglat Nuur.

It is interesting to compare the above recommendations with the usual procedures for the pasteurization of milk, which is one of the foods particularly associated with that process. These are, quoting Jacobs (1951), 62° C. (143° F.) to 63° C. (145° F.) for 30 minutes, or 71° C. (160° F.) for 15 to 30 seconds, followed in both cases by rapid cooling to 10° C. (50° F.).

Summarizing the above, it may be said that it is useless to pasteurize

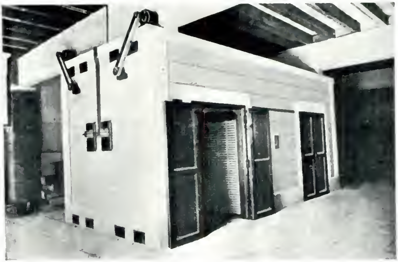


Figure 124. – Four chambers, back to back in one block, for use as date dehydrators or pasteurizers. The chambers are heated by radiators supplied with superheated steam. Marseilles, France.

dates which are so moist, say with 40 to 50 percent water, so that they do not lose enough moisture during the process to prevent their early decay. Even if all the micro-organisms of fermentation have been killed, the dates, as soon as they have cooled, are invaded by others. On the other hand, the packer or repacker of dates containing no more than 20 percent can improve their quality by pasteurizing them at a high relative humidity, say 75 percent or over. For dates between these two extremes, pasteurization is useful in reducing the number of micro-organisms on the dates, in reducing the moisture somewhat, and thereby making a better-keeping fruit.

Perhaps a temperature of 65° C. (149° F.) for two hours would be a suitable one for the prospective packer to use as a basis for his trials with different varieties, and containing varying amounts of moisture. Relative humidity might be up to 75 percent for dry dates and down to 25 percent for wet ones.

Equipment for the pasteurization of dates is shown in Figures 124, 125 and 126.

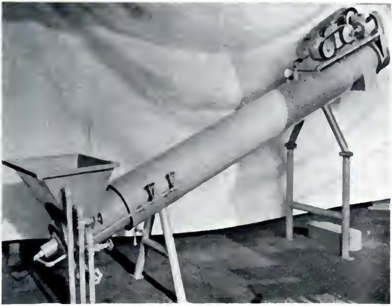


FIGURE 125. – Processor-pasteurizer. Fresno, California, United States.

Dehydration

The drying that takes place in maturation chambers is largely by simple evaporation, i. e., the air is circulated by natural draft. In dehydrators provision is made for drying to be accomplished by means of a strong current of air, the temperature, humidity, volume and speed of which are under control. The loss of moisture in the fruit, therefore, can be rapid. Humidity control is by means of the adjustment of the relative volumes of fresh air and of circulating air, whereas in maturation chambers it is usually by means of evaporating water from open pans.

Dehydrators may be of the batch type, as used widely in Algeria, Tunisia, France and Italy, or of the tunnel type, first used for dates in Libya in 1955 and later adopted by some of the date-packing houses in California (Figure 127).

Perry (1946) uses the term dehydrat*er* for a mechanical drier and reserves the word dehydrat*or* for the operator of the machine; but the name

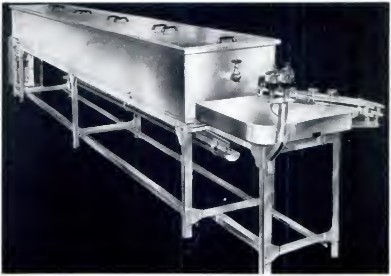


Figure 126. – Jar sterilizer for syrup and jarred dates. Rugby, England.

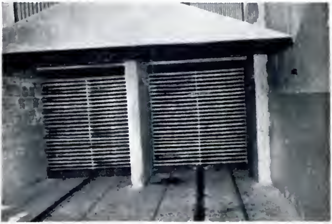


Figure 127. – The dehydrator in the Government Date-Packing House, Tripoli, Libya. Cold end. Partly filled. The cowl in the foreground is for collecting the damp air after it has passed over the dates on its way out through the roof.

of the machine in the technical literature is nearly always spelled dehydrator. Therefore, and by analogy with accumulator, radiator, refrigerator, separator, etc., dehydrator will be used in this study for the machine.

RATE OF DRYING

Table 27 shows the rapidity with which dates may be dried in a batch-type dehydrator heated by steam coils.

TABLE 27. – Rapidity in drying dates by using a batch-type dehydrator heated by steam coils

Date (Basra) 1931	Percentage loss of weight of Hallaawi dates on experimental trays	Average temperature °C. (°F. in brackets)	Time in hours
27 July	6.1	62 (144)	1.75
28 "	12.7	69 (156)	4
29 "	14.8	66 (150)	6
31 "	6.5	57 (134)	4
4 August	11.3	69 (157)	4
6 "	15.4	70 (158)	5
18 "	16.9	69 (157)	5
19 "	16.3	61 (141)	5
Average	12.5	66 (150)	4.34

The average reduction in moisture content was 10 percent, from 30 to 20 percent, the preferred packing percentage for Basra Hallaawi, or about 1 percent in 26 minutes at 66° C. (150° F.). The loss of moisture was 42 percent of the original moisture content. Humidity was not recorded.

DRYING RATIO

The drying ratio, that is, the ratio of the weight of the fresh material to that of the dried product, was thus 1.14. In other words, the packer had to buy 1.14 tons of dates (disregarding culls for the moment) to give him 1 ton after dehydration. For comparison, a few ratios are given below.

Percent moisture		Drying ratio
from	to	
30	20	1.14
34	20	1.21
40	20	1.33
50	20	1.60

These compare with West (1952) as follows:

Prunes (United States)	2 - 3
Cherries (United Kingdom)	3
Plums " "	3.5 - 4.6
Pears " "	7
Apples " "	8

The drying ratio is useful to the packer, in that it provides him with a ready formula for calculating his outturn from a given quantity of dates admitted to the dehydrator. The formulas are:

$$\text{Drying ratio} = \frac{S_1}{S_2} \text{ or } \frac{100 - M_2}{100 - M_1} \text{ or } \frac{T_1 + 1}{T_2 + 1}$$

where S_1 = initial weight
S_2 = final "
M_1 = initial % moisture
M_2 = final " "
T_1 = initial moisture ratio
T_2 = final " "

MOISTURE RATIO

A better measure of moisture content for purposes of dehydration than either the percentage moisture content or the drying ratio is the moisture ratio. This is the relationship between the amount of moisture and the amount of dry matter in the fruit or, in other words, the number of kilograms of water for every kilogram of dry matter. The reason it is better is that by using the weight of dry matter in the fruit, which remains constant during drying, instead of the total weight of the fruit, which fluctuates, a static basis for comparison is provided, and therefore a clearer presentation is obtained of the changes taking place. Thus for fruit containing 99 percent moisture, the moisture ratio would be 99; for 90 percent it would be 9; for 50 percent 1; and for 1 percent 0.01. A table showing the relationship between percentage moisture and moisture ratio (taken from Perry, 1946) is given in Table 28.

The formula for the calculation of the moisture ratio is:

$$T = \frac{M}{100 - M}$$

where T = moisture ratio
and M = moisture as percentage of total weight of fruit

In the example given above of dehydration of Hallaawi dates in Basra, the average reduction in moisture ratio was 0.18 from 0.43 to 0.25, corresponding to the fall in percentage moisture of 10 from 30 to 20.

The date packer may receive dates having percentage moisture varying from 15 to 50 percent, that is, with moisture ratios of 0.177 to 1.000, whereas the prune packer usually receives the fresh fruit at about 75 percent moisture, that is, with a moisture ratio of about 3.000.

DEHYDRATORS

Dehydrators can be simple chambers provided with easy means of heating and circulating the air. They can be somewhat less simple and more efficient if made of material which gives good insulation, if provided with steam coils, with a powerful fan to circulate the air over coils and then over the dates, with flaps to allow the hot air to be recirculated or not, at will, and with means of reversing the air flow. They can also be of the even more efficient tunnel type, with large capacity and directly drying the dates with the heated air and products of combustion from a large oil-fired burner.

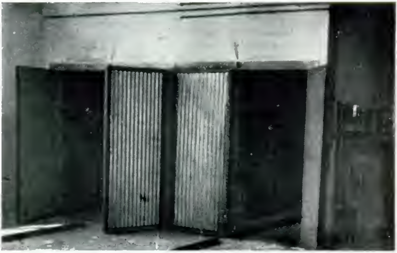
These last dehydrators have been extensively used for dried fruit other than dates, especially during and since the last war, but for dates they were not used until 1955. It would seem that their use could be extended to

TABLE 28. – Relation between moisture content expressed as T (parts of water per part of bone-dry matter) and as percentage on wet basis

Percentage moisture	T	Percentage moisture	T	Percentage moisture	T	Percentage moisture	T
90.0	9.00	84.8	5.58	71.0	2.45	25.0	0.333
89.8	8.80	84.6	5.49	70.0	2.33	24.0	.316
89.6	8.62	84.4	5.41	68.0	2.12	23.0	.300
89.4	8.43	84.2	5.33	66.0	1.94	22.0	.282
89.2	8.26	84.0	5.25	64.0	1.78	21.0	.266
89.0	8.09	83.5	5.06	62.0	1.63	20.0	.250
88.8	7.93	83.0	4.88	60.0	1.50	19.0	.234
88.6	7.77	82.5	4.71	58.0	1.38	18.0	.220
88.4	7.62	82.0	4.56	56.0	1.27	17.0	.205
88.2	7.47	81.5	4.41	54.0	1.17	16.0	.190
88.0	7.33	81.0	4.26	52.0	1.08	15.0	.177
87.8	7.20	80.5	4.13	50.0	1.00	14.0	.163
87.6	7.06	80.0	4.00	48.0	0.92	13.0	.150
87.4	6.94	79.5	3.88	46.0	0.85	12.0	.136
87.2	6.81	79.0	3.76	44.0	0.79	11.0	.124
87.0	6.69	78.5	3.65	42.0	0.73	10.0	.111
86.8	6.58	78.0	3.55	40.0	0.67	9.0	.099
86.6	6.46	77.5	3.44	38.0	0.61	8.0	.087
86.4	6.35	77.0	3.35	36.0	0.56	7.0	.075
86.2	6.25	76.5	3.26	34.0	0.52	6.0	.064
86.0	6.14	76.0	3.17	32.0	0.47	5.0	.053
85.8	6.04	75.5	3.08	30.0	0.43	4.0	.042
85.6	5.94	75.0	3.00	29.0	0.41	3.0	.031
85.4	5.85	74.0	2.85	28.0	0.39	2.0	.020
85.2	5.76	73.0	2.70	27.0	0.37	1.0	.010
85.0	5.76	72.0	2.57	26.0	0.35	0.0	0.000

advantage in those places where much of the date crop does not ripen properly on the palm, in the United States, Mexico, Libya, the northern part of the United Arab Republic, Israel, the coasts of the Red Sea and the Persian Gulf, in West Pakistan (Makran), the Northwest Frontier Province, the Punjab, and Somalia. Their capital cost is not very high and their running cost is low.

The most modern of these tunnel-type dehydrators has the cold end, that is, the end into which the dates enter, open, and the other end is provided with doors (Figure 128). The burner is above the tunnel or tunnels and has sliding doors between it and the outside air. When these doors are closed, the burner sucks up the damp air issuing from the stacks of trays of dates in the tunnel or tunnels and recirculates the whole of it. When the sliding doors are fully open, the burner sucks in all new air and the damp, cooled air from the stacks is sucked out onto the roof of the



Figures 128. – The dehydrator in the Government Date-Packing House, Tripoli, Libya. The hot end, with doors open.

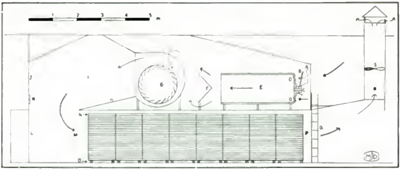


Figure 129. – Diagrammatic vertical cross section of dehydrator. Government Date-Packing House, Tripoli, Libya.

A. Electricity supply to burner. B. Oil supply to burner. C. Burner. D. Two fine air-adjusting flaps. E. Combustion chamber. F. Deflection cone. G. Blower; H. Floor. I. Air collection and direction-changing chamber. J. Hot-end wall. K. Wet and dry bulb thermometers. L. Hot-end doors. M. Hot end. N. Tray. O. Trolley. P. Cold end. Q. Ladder to burner chamber. R. Exhaust air shaft. S. Exhaust air shaft fan.

(Courtesy Mrs. Joy Dowson)

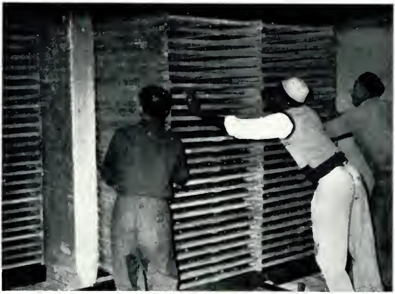


FIGURE 130. – Loading the dehydrator by hand before the installation of the hydraulic loader. Government Date-Packing House, Tripoli, Libya.

dehydrator building by means of a powerful exhaust fan situated at the bottom of a large duct at the top of a canopy just outside the entrance to the tunnel or tunnels. Thus the amount of air recirculated is controlled by altering the amount of the opening between the two sliding doors.

The burner flame burns in a large cylindrical combustion chamber lined with fire brick or similar material, and the heated air together with the products of combustion, assisted by suitable baffle plates, pass to a high-capacity fan which drives the air against the rear baffles and the rear doors, whence it is deflected over the dates at an average speed of perhaps 180 meters a minute (Figures 129 and 130).

The calculation of the size of dehydrator required for any particular date-packing house depends upon the total quantity of dates likely to need dehydration in any one day, on the amount of dehydration they would need, and on the speed of dehydration. The possible speed depends on the form of the dates – whole, halves, slices or mashed (the smaller the piece the quicker the drying), on the kind of date, the amount of heat the particular date can stand without excessive browning, caramelization, or case-hardening, the initial moisture content of the date, and the final moisture content required. Having decided on the maximum temperature the dates can stand, the amount of water to be removed from them, and on the quantity that must be treated in each batch, the date packer or, more probably, the dehydration engineer advising the packer, has to calculate the cross section and length of tunnel or tunnels, and the sizes of burner, fan and motor required.

The higher the temperature, the more quickly do the dates dry. Perry *et al.* (1946) illustrate this as follows:

Temperature of circulating air		Relative drying rate for prunes
°*C.*	°*F.*	*Percentage*
66	150	0.68
68	155	0.78
71	160	0.89
74	165	1.00
77	170	1.12

The greater the velocity of the air moving over the dates, the more quickly do the dates dry. The following statement, adapted from the same publication, shows the following:

Velocity per minute		Relative drying rate for prunes
Meters	*Feet*	*Percentage*
91	300	0.87
122	400	0.92
152	500	0.97
183	600	1.00
244	800	1.06
305	1 000	1.11

The drying rate for dried fruit is very nearly the same as the moisture ratio. Thus the wetter the fruit, the faster it loses water. As it dries, the rate of loss becomes slower.

For further information on the principles of fruit dehydration, reference is made to the publication of Perry *et al.* (1946), which contains a useful bibliography, and to Ede and Hales (1948).

Barreveld (1959) studied the operation of the Tripoli dehydrator. The particulars of the process at the time of his study were:

Date	Bikraari halves
Initial moisture	25 %
Final moisture	17 %
Temperature, hot end, dry bulb	81°C (179°F.)
wet bulb	41°C. (104°F.)
R.H.	10 %
Temperature, hot end, air round date	78°C. (172°F.)
in date	75°C. (167°F.)
Temperature, cool end, dry bulb	56°C. (133°F.)
wet bulb	41°C. (106°F.)
R.H.	41 %
Time	160 minutes

He noted that there was somewhat too much recirculation.

These hot-end temperatures would be considered high in California and, indeed, the pitted Bikraari halves come out of the dehydrator very hard, leathery, and too dry for the American market, but a curious fact is that they come out lighter in color than they go in. Perhaps the sulfur dioxide in the products of combustion of the gas-oil fuel causes the difference, but analyses for sulfur content before and after dehydration have not been made. Jacobs (1951), however, mentions that oil-fired burners generate enough sulfur dioxide to cause potatoes under normal dehydration to pick up at least 100 to 500 parts per million of that gas. Another curious fact with Bikraari under dehydration, quite contrary to the behavior of the Daglat Nuur, is that, as recorded by Barreveld, stored Bikraari dates after dehydration at a nominal 80°C. (176°F.) retained their lightish yellow color better than those dehydrated at 70°C. (158°F.), and much better than those dehydrated at 60°C. (140°F.). Barreveld ascribes this result to the more complete destruction by the higher heat treatment of the enzymes causing, or assisting, browning than that at the lower heat.

Postlethwaite (1927) advocated dehydration at 66°C. (150°F.) at a relative humidity of 30 to 35 percent for six hours followed by one hour at 79°C. (175°F.) to ensure a temperature of 71°C. (160°F.) in the center

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of the date. Three years later he advocated 60°C. (140°F.) to 66°C. (150°F.) for three to four hours. Albert (1935) recommended 54°C. (130°F.) at 50 percent relative humidity for ordinary soft dates and 60° C. (140°F.) for very wet dates or for dark-colored varieties.

In fact, for the most efficient operation of the dehydrator, there is an optimum temperature and an optimum relative humidity for every moisture content in the date, but having calculated what those two optima are from the moisture content, the packer still needs to experiment to discover the idiosyncrasies of the particular date with which he is dealing.

Freezing

In 1949, in *Progress Report* No. 1139 of the Texas Agricultural Experiment Station, there was reported the successful maturation of Dairi, Khadhraawi, Khastaawi, and Khisaab dates by freezing. The dates in the *khalaal* stage were completely frozen at –27°C. (–17°F.) and at –18°C. (–0.4°F.) for 15 hours, spread out to thaw and to dry for two hours, and then put in a warm ripening chamber at 32°C. (90°F.) for eight hours or a little more. The dates were then soft and syrupy, and were stored in a refrigerator. They darkened rapidly at atmospheric temperatures. The very low temperature presumably caused the cells to break down, thereby releasing the enzymes or those bodies responsible for darkening.

In 1950, Monciero reported that completely immature Daglat Nuur dates ripened very quickly at low temperatures but turned brown quickly when removed to a warm room. He continued his experiments, and in 1954 reported that with immature Daglat Nuur dates (that is, *khalaal* dates that showed no softening, and which, when spread on trays to mature at atmospheric temperature or in a heated chamber produced only very inferior fruit) deep freeze gave perfectly normal, ripe fruit of good quality, with the exception of a very slight bitterness, which disappeared after 20 to 25 days.

His treatment was as follows: washing, rapid drying, freezing at –10°C. (14°F.) for from 12 to 24 hours according to the stage of maturity of the dates, rapid drying for ½ hour, thawing for 1½ hours, maturation at from 38°C. (100°F.) to 42°C. (108°F.) for from 15 to 25 hours, sulfuring (during or after maturation) for 3 hours, and then a further heating to 40°C. (104°F.) for 20 to 24 hours. In this way an excellent, light-colored product was obtained in two or three days from dates that were too immature to have ripened properly otherwise.

The method outlined above, however, does not seem to have been adopted commercially.

Hydration

The hydration of dates in the gardens is a process as old as date packing. Dates which are too dry are heaped on mats in the hot sun in the garden, sprinkled with water from time to time, kept covered with mats and, if necessary, the heap is turned with a shovel. After a week or so of this treatment, the condition of the dates has much improved, that is, the texture of the flesh is moister.

The reason why dry dates are hydrated is because most people prefer soft ones. Another reason, as noted by Freeman (1911) and by Husson (1931) is that if the date has dried before it has matured, it is necessary to hydrate it before its maturation can be continued, for, unless there is sufficient moisture in the date, the enzymes that promote maturation are unable to exercise their functions.

ABSORPTION OF MOISTURE FROM THE AIR

Dates, like other dried fruit and other stored products, absorb moisture from the air when it is humid, and give it up when the air is dry, so that just by simple storage in a humid atmosphere dry dates can by hydrated and thereby made softer. Table 29, taken from Barger (1936), confirms this fact.

TABLE 29. – Percentage of total gain in weight of dry Daglat Nuur dates (14 percent moisture) in humid air

Temperature		Relative humidity	Days			
°C.	°F.		(2)	(5)	(8)	(11)
			Percentage			
38	100	98	5.3	13.0	18.7	—
38	100	86	1.6	3.9	5.8	—
38	100	75	1.2	2.8	4.3	5.6
38	100	65	—	—	0.3	—
27	80	98	3.2	7.7	11.1	—
27	80	86	1.0	1.7	2.1	—
27	80	75	0.7	1.4	2.1	3.2

It will be seen, however, that this method is slow, and its employment therefore necessitates a large number of trays and much storage space. There is also the risk that the dates will mold on the surface before they have absorbed enough moisture to soften them inside (see also Barger, 1933).

In cold storage, as Barger (1936) has shown, dates can be hydrated by being stored in a humid atmosphere without being subject to molding. Table 30, taken from his paper, shows that an increase of 10 percent moisture can be achieved in seven weeks cold storage at 98 percent relative humidity; but cold storage is expensive for dates loosely spread on trays and not packed compactly.

TABLE 30. – Percentage of gain in weight of dry Daglat Nuur dates (14 percent moisture) in humid cold storage at 1° C. (34° F.)

Relative humidity	Total gain in weight (after so many weeks)			
	(3)	(5)	(7)	(15)
	Percentage			
98	4.6	7.3	10.6	18.9
86	1.6	3.0	4.3	7.9
75	1.2	2.1	3.2	5.4

TRANSFER OF MOISTURE FROM ONE DATE TO ANOTHER

Dates will also absorb moisture from each other when tightly packed together. Thus in an experiment carried out in Basra in 1936, very soft *tamar* Hallaawi dates were packed alternately in a box with very dry *abul khusheim* Hallaawi, that is, hard dates with shrivelled, reddish apices and cream-colored shiny bases. The box on arrival in Brooklyn, New York, five weeks later, was found to contain dates which were nearly all of fair average quality. Barger (1930) also mentions the improvement in the texture of Daglat Nuur dates of 15 percent moisture packed with others having 24 percent moisture after one month's storage in a cellar at a temperature of from 10°C. (50°F.) to 16°C. (60°F.)

COLD WATER

Attention was first directed to the hydration of dates in the packing house when the French growers in Algeria and Tunisia, having planted a great number of Daglat Nuur shoots, found that a part of the crop was always dry instead of soft. Before the advent of the French into the date industry no one had worried about the dry dates, for they found a ready sale to the nomads, who preferred a dry date to a sticky one. The French growers, however, wishing to sell as much as possible of their crop to the more profitable European market, sought means of making the dry dates acceptable to it. The method they adopted was that of simple soaking of the dates in vats of cold water for some time, emptying the vats of their dates and water through large-diameter valves (Figure 131) into washing baskets, where the excess moisture drained off and where the dates remained for some hours to absorb the rest. By this method the dry dates were somewhat softened, but it was not very satisfactory because the penetration of the water into the date was slow, so that either the center of the date remained hard or the surface became mushy and perhaps fermentation started.

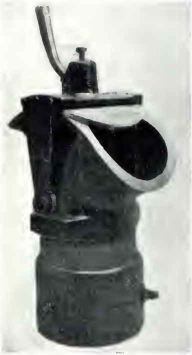

FIGURE 131. – Wide-mouthed discharge valve for date-soaking vat, which allows rapid escape of dates with the water without damaging them. Marseilles, France.

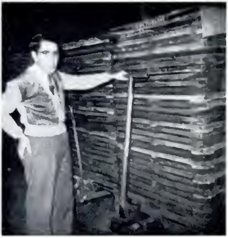

FIGURE 132. – Dates hydrated by steam cooling off on trays outside hydration chamber. California, United States.

HOT WATER

Soaking in hot water hastened the softening process, but it also hastened mushiness and fermentation, so that the time and temperature had to be chosen with some precision for each batch of dates and neither exceeded.

The first mention of hydrating dry dates with cold and hot water in the United States is by Freeman in the classic bulletin by that worker and Vinson in 1911. He used water at 40° C. (104° F.) to 45° C. (113° F.).

STEAM

The use of steam (Figure 132) for hydrating dates seems to have developed from its use primarily for another purpose, namely, the heating of cases of tightly packed dates after removal from cold storage, in order to facilitate the removal of the dates from the cases and their separation from each other before being repacked in cartons. It was found that the steam improved the appearance of the dates by giving them a gloss, and that it also slightly increased the moisture content. The process was developed by a prominent firm of repackers of Iraqi dates in Brooklyn, New York, about 1920. Ten years later, the Marseilles repackers had adopted steam to hydrate the dry Daglat Nuur, the *frezza* of French literature.

Steam is quick, easy to control, successful, and effects at least partial pasteurization as well as hydrating.

By 1936, when Barger wrote his useful paper, the use of steam for hydration had become common in Californian packing houses. He states that dry Daglat Nuur dates with about 15 percent moisture gained 3 percent in weight in 2 hours and 15 percent in 16 hours of steaming at 49° C. (120° F.) to 54° C. (130° F.).

Barger noted that the process of hydration caused considerable inversion of sucrose in the Daglat Nuur dates, and he was the first to remark that the greater the moisture in the date the more rapid is the inversion. He also points out that a part of the softening of the date is due to the absorption of water and a part to the inversion of the more solid sucrose to the more syrupy invert sugars.

In 1944, Rygg presented his excellent paper on glazing and hydrating dates at the twenty-first Date Growers' Institute meeting. He found that dry Daglat Nuur gained from 7 to 9 percent in weight by being held for two days at 47° C. (117° F.) and 90 percent relative humidity. They did not become sticky nor develop mold. In his laboratory, he used open pans of water to humidify the atmosphere, but there would seem to be no reason why steam could not be used on a commercial scale.

In a later paper (1958) Rygg mentions that the texture and appearance of dry Daglat Nuur dates were improved experimentally by being heated for a short time at a low steam pressure in a pressure cooker.

VACUUM

The extremely simple procedure, discovered apparently about 1950, and developed by an American named Richert, of subjecting dates while soaking in water to a vacuum has revolutionized the process of date hydration. A wire basket is charged with the dry dates and lowered into cold water in a vacuum tank. The lid is screwed down and a vacuum is drawn on the air above the water, until the atmospheric pressure is reduced in the tank to about 120 millimeters. The vacuum is then released, the wire basket of dates withdrawn, and the dates are tipped into boxes to drain and for the flesh to absorb the water in the cavity between the pit and the flesh that has been drawn into it by the extraction of the air that was there before. In ordinary soaking the water cannot penetrate there, being kept out by the air. In a couple of days the dates have absorbed 5 to 10 percent moisture or more, are plump and pliable, and in much better condition than dates hydrated in other ways (Figure 133).

Rygg (1958) states that dry dates often have a low *p*H value, and that the lower the *p*H, the more difficult it is to soften them either by steam or vacuum hydration. He therefore suggests the addition of 1 to 2 parts per 1,000 of ammonium sulfite to the hydrating water to make it more alkaline. The action of this salt furthermore helps to prevent the dates from darkening.

For large quantities of dates an improved hydrator, using the same principle, is on the market (Figure 134). The dates are fed into a galvanized iron tank of, say, 2-cubic meter capacity, three quarters full of water. Another tank of similar size is set some distance away at a lower level, say 1 meter lower. The two tanks are connected at points near their bottoms by means of a pipe of about 5 centimeters in diameter. In this pipeline a small centrifugal pump is set to pump water from the lower to the higher tank. The fourth component of the machine is a pipe of aluminium alloy of 15 or 20 centimeter diameter made in the shape of a wide inverted V, with one arm of the V longer than the other. The shorter arm dips under the water to near the bottom of the higher tank; the longer one dips under the water to near the bottom in the lower tank. The point of the V may conveniently be suspended from the roof of the building in which the machine is housed. The top of the V is bulged, and in the top of the bulge a small pipe connected with a suction pump is inserted.

The pump is set going; water is sucked up from both tanks in both arms of the V, but the leg from the higher tank being shorter than the other, the water in this leg will reach the apex before the water in the longer leg. The only places where this water can then go are into the narrow suction pipe or down on top of the water already three quarters of the way up the longer leg. Once contact is established between the water in the two legs, the column of water in the longer leg, being longer than that of the water in the shorter leg, now falls back into the lower tank and sucks the water in the shorter leg and in the higher tank with it. A constant flow is now established of water from the higher tank to the lower one, but the loss of water in the higher tank is made good by the water pumped from the lower tank through the pipe along the ground.

There is now a continuous stream of water from the lower tank to the upper one through the ground pipe, and from the higher one to the lower one through the ceiling pipe. The dates are sucked up with the

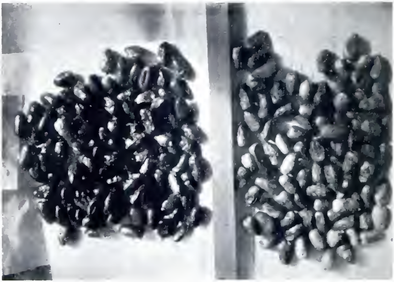

FIGURE 133. – Dates hydrated in cold water in experimental vacuum hydrator. The dry, Ibil dates on the left contained 13 percent moisture. Those on the right, which had been hydrated under a vacuum of 660 millimeters (26 inches) for 2 minutes and left to drain for 24 hours, contained 41 percent moisture.

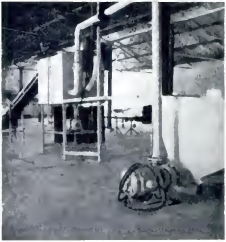

FIGURE 134. – Equipment for adding moisture to dates under vacuum. Government Date-Packing House, Kareima, Merowe, Sudan.

water from the higher tank, pass through the ceiling pipe, fall into the lower tank, whence they are extracted by a continuous chain elevator.

A trap is provided in the air suction pipe between the bulge and the suction pump to catch the water on its first rush up into the bulge, and as soon as contact is established between the two lots of water in the two legs, a cock is turned off in the suction pipe and the suction pump switched off.

The water, as it is dragged up the short leg by the pull of the descending column of water in the long leg, is subjected to a slight vacuum. This vacuum is sufficient to cause the air inside the date to be extracted and to form bubbles in the water, the result being that water takes its place. The amount of the vacuum produced depends upon the difference between the water level in the top tank and that in the bulge over the apex of the V. The greater the difference, the greater is the vacuum, that is, the less is the pressure of the atmosphere.

The design of this machine is simple and ingenious. It works well and its operation costs are negligible.

Secondi (1948) and Aubrun (1948) both mention a process for the hydration of dates developed before the second world war by M. Torcol by means of heat, steam and vacuum. But Secondi adds that the results obtained by this method have not given entire satisfaction.

Glazing

In the packing houses of Algeria, Tunisia and France, dull Daglat Nuur dates, especially those that had been hydrated by soaking in water, were commonly dipped in a sugar syrup, with or without addition of glycerine, to give them a gloss. However, the first notice in the literature of the use of glycerine seems to be that in *Leaflet No. 3* of the Horticultural Section of the Ministry of Agriculture, Egypt, of 1915, in which the dipping of dates before packing into a solution of 80 percent alcohol, 15 percent glycerine and 5 percent water is advocated for Siwi and Gattaawi dates.

Another treatment was a light brushing with a purified, colorless, tasteless mineral oil. One such oil, of German manufacture, used to be on the market under the name of Dattelöl. An emulsion of oleic acid and pearl ash has also been used. In 1948 Aubrun stated that hydrated dates could be given a gloss by short drying in a dehydrator followed by rapid cooling by means of a strong current of cold air.

Rygg (1944) studied the matter of glazing in dates and found it could be produced by melting the waxy bloom on the surface of the skin so that it spread over it evenly. He found that there are at least two fractions in the wax, the smaller part melting at about 72° C. (162° F.), and the greater part melting at about 84° C. (183° F.). As the author says, " ...the time required to produce the luster depended upon the exposure of the surface of the fruit to the surrounding air and upon the closeness of the contact of the skin with the flesh beneath, as well as upon the moisture content of the flesh, i. e., it depended upon the rate at which the heat was conducted away from the surface of the fruit toward the interior, as well as upon the rate at which heat was conveyed to the surface from the outside."

His final recommendation for producing a gloss on dates is: Dates one layer deep on open tray, five minutes at 130° C. (266° F.) to 140° C. (284° F.), with a fan in the oven to keep the air moving rapidly.

Ripening agents

As has been noted in the section " Field Ripening and Curing " (chapter 3), the ancient practice in Spain and elsewhere of enclosing *khalaal* dates in jars with a little vinegar for a short time, hastens their transformation into *rutab*, that is, their ripening. Samish (1957) also mentions the use of a 0.01 percent spray of acetic acid on the bunches of the *khalaal* dates on the palm in Israel to promote ripening.

It was apparently the Spanish practice that suggested to Vinson the trial of the application of various chemicals to dates in order to hasten ripening. He gives a long list of these in his classic bulletin of 1911, but found acetic acid the best of them all.

Vinson's theory explaining how the chemicals acted is given below in his own words:

> " The great dissimilarity in chemical structure of the various substances which set up premature ripening, excludes all possibility of the phenomenon being a purely chemical one. In fact, very few of these substances react chemically with any known constituent of the date. After treatment overnight with acetic acid vapor, however, a very appreciable reaction for the hitherto insoluble invertase could be obtained with the glycerol extract of the translucent date. While invertase is not essential to ripening, its behavior is probably typical for many other catalytic substances involved in the process. The

mobility thus given the enzymes permits free molecular contact, with consequent reaction, between substances previously kept apart by the living protoplasm. In broad terms, we may formulate a theory of the artificial ripening of fruits as follows: Any substance which will penetrate the tissues and kill or stimulate the protoplasm in such a way as to release the previously insoluble intracellular enzymes without rendering them inactive, will bring about ripening, provided the fruits have reached a certain necessary degree of maturity.

" This theory was tested by an experiment devised to accomplish the same result by purely physical means. Sprays of the same seedling date used in the chemical stimulation experiments were heated in water for five and ten minutes at every 5 degrees between 60° C. and 95° C. Below 60° C. they lost their astringency but remained very light colored, like untreated fruits. Above 60° C., the color became darker, reaching a maximum at about 75° C. At 80° C. the general aspect of the sprays was more uneven, and even the darkest individuals remained exceedingly astringent and very sweet. Above 80° C. the color of the entire spray became a light sulfur yellow, matching exactly the more immature individuals heated below 60° C. Unlike the results obtained by treatment with chemicals, the effects of heat stimulation became plainly manifest only after the lapse of several days. The results, however, show clearly that if dates are heated sufficiently to destroy protoplasm but not enzymes, the ripening phenomenon will follow quite completely, while at higher temperatures normal ripening ceases. "

Seventeen of the chemicals tried by Vinson were tried in Basra in 1934, but in the climate of that place natural ripening gave results so much better than those of the chemicals that further experiments were discontinued. In the United States also it was found that the results of chemical treatment were inferior to those of the other methods employed there, that is, to those of artificial heat.

Forbes in 1917, however, had reported that carbon dioxide would promote ripening and, ten years later, its use was still being advocated by Fattah, but by 1935, Albert and Hilgeman report that it was no longer used.

Ethylene had a vogue for a short time after Denny's discovery in 1923 that it hastened coloring in oranges, lemons and in various other fruits including dates, but it also was found to given results inferior to those obtained by heat. However, its use has recently been extended to promoting the quick fermentation of tobacco (Bobier et Lepigre, 1952), and Munier (1955) suggests that its use with dates in the way found successful with tobacco would be likely to be successful with them also. The method involved the use of a vacuum, heat, water and ethylene as a starter. It reduced the time necessary for the fermentation of the tobacco by nine tenths. Girard, in a private communication (1960), mentions that it is hoped to install the necessary equipment to be supplied by a French firm for the maturation of dates by this method at the date experimental station at El-Arfiane.

Brown, T. W. (1924) states that *khalaal* dates of the Amhaat variety of Damietta, before being dispatched to Cairo and elsewhere, are steeped in brine in order to ripen them quickly. This process appears so simple that, if it had been effective it might have been expected to have spread but, in the literature, there seems to be no other mention of the use of salt for this purpose. Salt, however, is sometimes sprinkled onto the dates during packing in baskets by foot on the coast of Libya, but information is lacking on what effect it has and on what effect it is intended to have.

Preservatives

The regulations in the United Kingdom concerning the use of preservatives in food define a preservative as " any substance " (with the exception of certain specified common substances such as salt, sugar, and vinegar) " which is capable of inhibiting, retarding, or arresting the process of fermentation, acidification, or other decomposition of food or masking any of the evidences of putrefaction. " They prohibit the manufacture and sale of food containing added preservatives, with the exception of those foods which are specified, in which a specific preservative may be used up to a maximum proportion (Hinton, 1960).

The preservatives ordinarily used for dates are sulfur dioxide, sodium metabisulfite, ethylene oxide and a mixture of 15 percent ethylene oxide and 85 percent methyl formate called fumold. However, it is possible that the last two do not come within the legal definition of the term preservative if, after they have done their job of killing the organisms of decay, including their spores, they evaporate and leave no trace. No analyses of dates to determine whether this is so appear to have been published; but it is of interest to note that Canada, in its latest Food and Drugs

Act Regulations (1960), specifically mentions ethylene oxide and limits its permitted content in copra and whole spices to 50 parts per million.

Sodium metabisulfite and ethylene oxide are commonly added to the water used in hydration to prevent souring; and fumold, at the rate of 1 cubic centimeter to 454 grams (0.28 British fluid drachms, 0.27 U.S. fluid drams to 1 pound), is injected into each carton of dates immediately after packing and immediately before sealing. By using this mixture, dates can be marketed safely with about 4 percent more moisture than they could stand without it. As the price to the consumer remains the same, it is to the financial benefit of the packer that dates should be sold with as high a moisture content as is consistent with the required keeping quality. Customers also generally prefer a soft date to a dry one.

Nitrogen, although not a preservative, has somewhat the same effect as one, since its use excludes the oxygen of the air, which hastens the process of decay. Nitrogen, therefore, has been used with some success to replace air in canned dates (Nielsen *et al.*, 1950) and in airtight bags (Rygg, 1958).

6. PACKING

History

IRAQ

There has been a marked change and great improvement in the packing of Iraqi dates for export during the last hundred years. Until the 1860s dates were exported in baskets made of woven date palm leaflets into which the dates were pressed by foot. It is in such baskets that most of the Iraqi dates intended for home consumption are stored and they still carry most of the export to the ports of the Persian Gulf, Pakistan, India, southern Arabia and the east coast of Africa.

The basket has good qualities, in that it is simple and cheap to make, is made of local material, preserves the dates reasonably well from dust and dirt, and as the dates are pressed firmly in it, air and insects are kept out. However, it had serious disadvantages in the European and American trade. These were the difficulty of separating the dates once they had been squashed together, a difficulty both for the busy retailer and the repacker, the loss in broken and damaged dates caused during separation, and the repugnance felt by the consumer to a food packed by foot.

During the 1860s, firms began to export dates to Europe and America in wooden boxes which had previously been used for the import of tea, soap, candles, sugar, tinned provisions, etc. There was no proper packing; the dates were just shovelled into the boxes and pressed down (Jwaideh, 1950).

It was not until a little before the turn of the century that the noticeable advance in Basra date packing occurred, with the introduction by Count Albert Asfar in conjunction with the American firm for which he was packing, of the 70-pound standard wooden box specially imported for the date trade (Count Asfar, private communication). A marked improvement was now possible. This was the packing of the dates by hand, one by one (the more skillful women packed two by two) in straight rows and in even layers. As the number of rows in a box (generally 13 for Hallaawi and 14 for Istaamraan, for example) remained constant for the whole box, the block of dates, once the wooden lid, sides and ends had been knocked apart, could be readily split at its destination into quarters or whatever smaller division was required. The change gave a great impetus to the repacking trade, first in the United States and later in the United Kingdom.

A later development, early in the 1900s, was the hand packing of 1-pound cartons of dates arranged in lines two layers deep; but the dates received no fumigation and, as no care was taken to exclude insects before or after packing, a large proportion of the cartons were wormy by the time they reached the consumers in the United Kingdom and elsewhere. This infestation and the high differential between the duty on small packs of dates entering the United States and on dates in bulk gave an impetus to the repacking trade on the eastern coast.

It was not until 1926 that fumigation, pasteurization and steaming to add gloss and improve the appearance and texture of dates were introduced into Basra.

Another important development in the date-processing and date-packing industry was the introduction in 1954 of the washing machine, the vacuum hydrator and the open carton tray with a transparent film wrap.

NORTH AFRICA

In Algeria and Tunisia, there has been built up in the past three quarters of a century a valuable speciality trade in the Daglat Nuur date packed in the characteristic and well-known glove box (*boîte à gants*) which in peak years reached 30,000 tons, though most of this was packed in Marseilles (Figure 135). The trade, however, is declining with rising labor costs in North Africa and with increasing competition from small packs from Iraq. As Secondi noted in 1952, whereas for a kilogram of Daglat Nuur dates packed in glove boxes the cost of the container was 40.8 francs, the cost of the container for a cellophane-wrapped block was only 9.6 francs for the same quantity, that is to say, it was 31.2 francs cheaper, or 22 percent of the value of the dates.

UNITED STATES OF AMERICA

Labor has been comparatively expensive in the United States, and the glove box has never become established there, although until recently hand

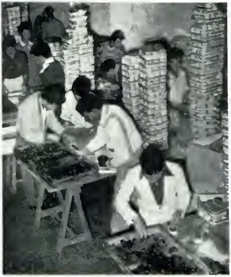

FIGURE 135. – Packing glove boxes, Tunisia.

(Courtesy Derocles and Cie., Tunis)

packing was usual. Currently the loose pack in the open carton tray with a transparent film wrap and with no arrangement of the dates by hand carries the bulk of the trade (Winter, 1949).

The packing house

In Iraq there are two large packing houses in Basra and Baghdad, operated by the Date Association. Some 14 additional units are planned to be established in various places of the date-growing districts. Construction has already started at Hilla, Karbala, Hindiya and Baquba. There are, furthermore, about half a dozen permanent, private packing houses in Basra, while every year over 100 temporary packing houses are erected on the banks of the Shatt el-Arab. The number of permanent private packing houses in Basra is less than it was because of the recent legislation making it an offence to discharge laborers or to reduce their pay. The number of packing houses in Tunisia is also less than it used to be, because of the pressure of the Marseilles packers and because the new labor law has set a minimum wage which the Tunisian packers find themselves unable to pay. Consequently, of the 13 packing establishments

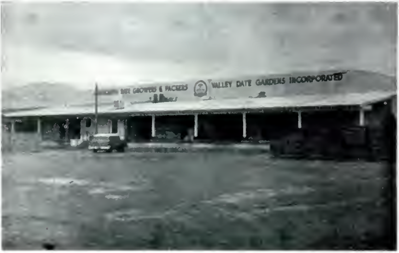

FIGURE 136. – Date-packing house in the Coachella Valley, California, United States.

in Tunisia in 1949, less than half are now in operation. In Algeria there are 7 or 8 packing houses.

In Iran, at Khorramshahr, a 2,000-ton packing house has been built and began to work in the 1960 season; three others are being planned. In the Sudan, one government packing house was established at Kareima (Merowe) in 1959. In Libya, one was put up in 1955. In California, in 1959, there were 31 private packing houses, handling between them 20,000 tons of dates (Figure 136). As five of these packed between them 11,000 tons, the average of the remainder must have been about 350 tons each (Stallings, 1959). In Arizona, there are a few small houses as there are in the United Arab Republic, as well as the experimental packing house of the Department of Horticulture (Ministry of Agriculture) at Gizeh, where in 1948 an American contractor installed pasteurizing, grading and packing equipment. There are also two modern, small, packing houses in Saudi Arabia.

As for repacking houses, there were 35 in the United States in 1935 repacking Iraqi dates, and in Italy there are about 15 repacking partly Iraqi dates and partly those from North Africa. The Marseilles repackers of North African dates also probably number about 15.

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ADVANTAGES OF MODERN PACKING HOUSES

Among the advantages of modern packing houses are firstly those which any factory process has over cottage industry, namely ease of inspection and control of quality, uniformity of pack, accurate weight of pack, etc., the possibility of filling repeat orders with the same kind of produce, saving of labor, good working conditions for labor, proper latrines, hot water for washing, lockers for clothes, dining hall and recreation room,

The special advantages of modern factory packing for dates are the following: The daily output is high, so that dates that have reached the proper stage of maturity can be dealt with rapidly and are not left to spoil. The large modern packing house is equipped to deal with dates in all stages of maturity, so that the best treatment for each stage can be given. Washing and cleaning machines are employed, so that the dates can be properly cleaned. Grading machines and good lighting aid proper grading, and packing and wrapping machines give good, quick and uniform packing and wrapping (Figures 137, 138, 139, 140, 141, 142, 143, 144). The modern packing house is hygienic. Insects are excluded by proper screening and fumigation on receipt of dates, and again while they are awaiting shipment. Air conditioning contributes to the comfort and work capacity of labor. Cold storage allows packing to continue all the year round, so that the labor force remains constant. Workers thus become more and more proficient and the services of the inefficient can be dispensed with.

SITING

The modern date-packing house should be as near as possible to its chief source of supply, in order that the dates may be received fresh and undamaged, and to enable the packer to watch the crop as it matures, so that he may form his own opinion as to the earliness or lateness of the season and of the size and quality of the crop. This will assist him to strengthen his position when the price has to be fixed and to establish friendly contact with the growers.

The modern date-packing house should also be as close as possible to good dispatching centers, that is, to a port with frequent sailings or to a main line railway station; in other words, to an important center of population. Thus it will have access, not only to adequate shipping facilities but also to electricity and water supplies, town sanitation, telephone, medical attention, engineering and electrical repair shops. It will also

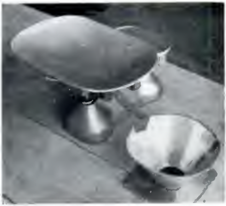

FIGURE 137. – Packing cellulose film bags. The scales and funnel with liner. Goverment Date-Packing House, Kareima, Merowe, Sudan.

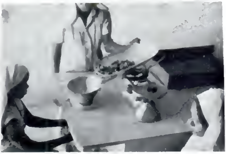

FIGURE 138. – The dates are weighed out. Government Date-Packing House, Kareima, Merowe, Sudan.

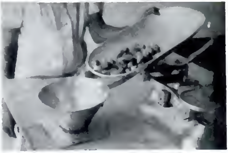

FIGURE 139. – The dates are tipped into the funnel. Government Date-Packing House, Kareima, Merowe, Sudan.

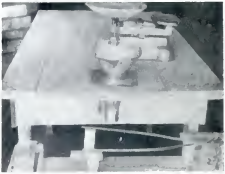

Figure 140. – The spout of the funnel is below the table. Government Date-Packing House, Kareima, Merowe, Sudan.

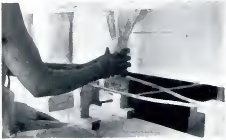

Figure 141. – The cellulose film bag is held under the spout and the dates fall into it. The bag is slid between the iron rods which close its mouth. Government Date-Packing House, Kareima, Merowe, Sudan.

Figure 142. – The hand heat sealer to seal the bags. Three girls complete 12 bags a minute. Government Date-Packing House, Kareima, Merowe, Sudan.

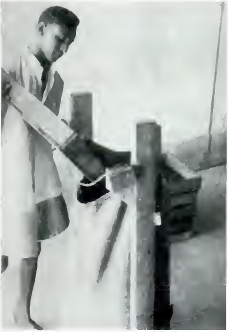

FIGURE 143. – Rejects being emptied from trays made of local wood into a sack for resale. Government Date-Packing House, Kareima, Merowe, Sudan.

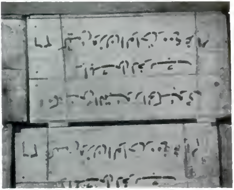

FIGURE 144. – Boxes ready for shipment. The inscription reads: Government Date-Packing House, Tripoli, Libya, 36 bags each weighing 400 grams.

be easier for the manager of the date-packing house to keep in touch with brokers, wholesalers, advertisers, date standards officials, date monopoly officials and other government authorities.

SIZE

The largest date-packing house in the date-growing region of the United States occupies about 10,000 square meters, but the over-all site of the Government Date-Packing House at Baghdad, including stores, fumigation section, etc., is probably greater.

The site of the Government Date-Packing House in Tripoli, Libya, occupies 5,265 square meters, made up as follows:

Operation floor	735 sq. m.
Fumigation stores	950 " "
Box store	260 " "
Offices, garage, fumigation control room, workshop, boiler and hydration chamber	259 " "
Tarmac surround	3 061 " "

The output is 3 tons of dehydrated Bikraari pressed date-cake slice (Figures 145 and 146) for schools in an eight-hour shift, so that the output in terms of space occupied is:

1 sq. m. of operations floor	4	kg. per shift
" " " " buildings	1.3	" " "
" " " " whole site	0.57	" " "

The output of a loose pack, or of a pack of Fezzani dates, would of course be much greater. In California, the output per square meter of site space in eight hours may be about 2 kilograms. Postlethwaite (1938) considered that the output per square meter of operations floor would be about 10 kilograms.

This quantity is what one would expect today under American conditions and with American-style packing for, although the speed of packing is retarded by the present trend toward pitted dates, it has been hastened by increased mechanization.

The tendency in the food-processing industry continues to be toward plants with ever-increasing capacities, and date-packing plants are no exception. They cannot be successful, however, unless their marketing

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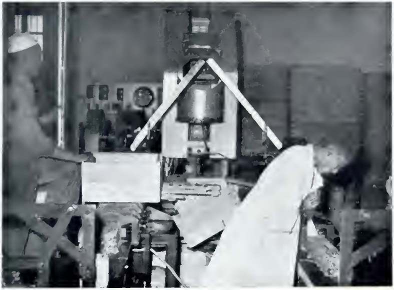

FIGURE 145. – Two electric-operated ram presses for making Bikraari date block. The dates, before sliding down the two supply shoots, have been raised higher than necessary. This was only because a spare elevator of this height was available. Government Date-Packing House, Tripoli, Libya.

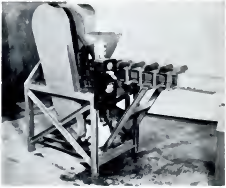

FIGURE 146. – Detailed picture of the presses shown in the previous figure.

arrangements keep pace with their increased production. In the present state of the world market for dates, a large packing plant should not be erected unless the disposal of its output is ensured by a capable organization, with an energetic sales division, adequate capital to advertise widely, and with no necessity for immediate profit.

Stallings (1959) considers that a large packing house in the Coachella Valley would pack over 1,800 tons of dates in a season, a medium-sized one about 1,000 tons, and a small one less than 150 tons.

The large date-packing house, of course, has the advantage of all large processing plants of being able to employ modern labor- and time-saving equipment. It is in a specially favorable position if it also handles other fruit when the date season is over.

The small packing house, generally run by a grower who with the help of his family or a few hired laborers grows most of the dates he packs, is suitable for the postal order trade, for fancy packs, and for the grower who has a number of different varieties of dates in his garden (Figures 147 and 148).

Most of the dates passing through packing houses are packed in medium-sized plants. Those with a seasonal capacity of perhaps between 100 and 1,500 tons are probably most suitable for the needs of date-producing regions where packing hitherto has been done only in a primitive way.

DESIGN

For economy and ease of operation the entire date-packing house should be on a ground floor level. Land in the vicinity of date gardens is usually cheap, so there is no great difficulty in having single-storey packing houses. Repacking houses in towns, however, may have to be accommodated on more than one floor of a building, with the receiving and dispatching ramps, and perhaps the storerooms, on the ground floor, and the rest of the accommodation on other floors reached by service lifts.

UNITS

The units of a date-packing house are:

Weighbridge
Receiving and dispatching ramps
Sampling room
Fumigation stores
Cold store

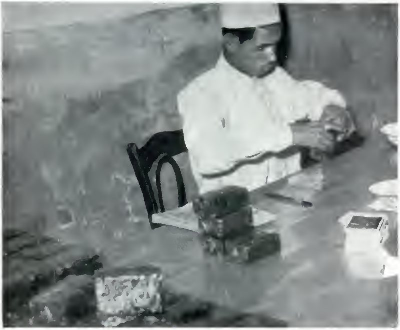

FIGURE 147. – Wrapping pressed blocks of dates in cellulose film by hand and glueing on labels. Small rural date-packing house, United Arab Republic.

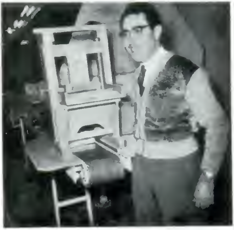

FIGURE 148. – Hand-operated machine for making tray cartons for dates. California, United States.

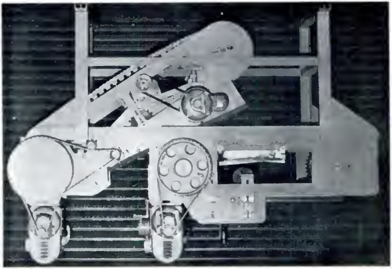

FIGURE 149. – Date-dicing (slicing) machine for cutting individual dates into slices. California, United States.

Operations floor, where the following operations are performed:

Picking the dates off the bunches
Dry cleaning and washing
Drying
Grading
Tray loading
Tray stacking
Tray unloading
Pressing
Slicing (Figure 149)
Pitting
Shredding
Mincing (grinding) (Figures 150, 151 and 152)
Hydrating
Making up trays, cartons, glove boxes, fibreboard cases and cans
Nailing up shooks
Lining boxes
Packing (Figures 153 and 154), filling cans and jars
Wrapping (Figures 155 and 156)
Sealing cartons, bags and trays
Sealing cans and jars
Sterilizing cans and jars
Labelling
Filling and lidding cases
Strapping and wiring cases
Stencilling

It is not likely that any one packing house would be equipped to perform all the above operations; these vary with the class of date used and with the type of trade supplied.

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Opening off from the operations floor would be the:

- Boiler
- Electric generating plant
- Maturation chambers
- Pasteurizer
- Dehydrator
- Syrup plant
- Box store
- Box and tray washer and sterilizer
- Fumigation control room
- Carpenter's shop
- Workshop
- Workshop store
- Packing materials store
- Clerk's office
- Manager's office (all glass with good view of operations floor, insulated against sound)
- Latrines, washrooms and cloakrooms
- Dining and recreation rooms
- Nurse's first aid room

WINDOWS

However desirable, it is seldom possible to provide ample window space, owing to the operations floor being more or less surrounded by

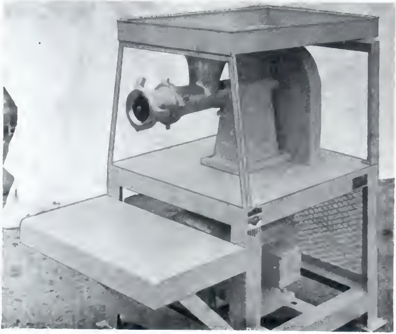

FIGURE 150. – Date mincer (grinder). Fresno, California, United States.

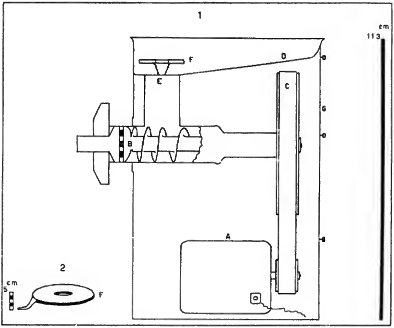

FIGURE 151. – Date-mincing machine.

1. Vertical section of mincing machine (side view); Electric motor A turns mincer worm B by means of belt C. Dates are placed in feed pan D and prevented from blocking feed canal E by a circular plate with a hole in its center F. G. is a movable panel giving access to moving parts. 2. Detail of circular plate F. Date-Packing House, Tripoli, Libya.

(Courtesy Mrs. Joy Dowson)

other units of the plant, in order to keep the distances the dates must travel as short as possible. Whatever windows there are, however, and all doors, should be screened.

Roof windows can be used, provided they are vertical and face north, so that direct sunlight is not admitted.

ELECTRICITY

Most packing houses depend almost entirely on artificial lighting. Above graders and packing units at least 20 lumens are necessary and elsewhere at least 10.

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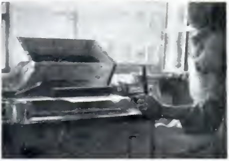

FIGURE 152. – Mincing Taabuuni dates with hand mincer for half cubes for cellophane-wrapped trays. Experimental Date-Packing House, Tripoli, Libya.

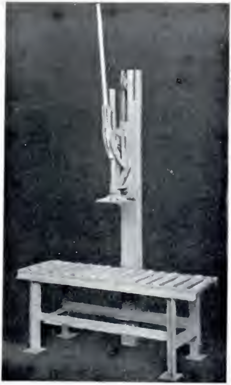

FIGURE 153. – Hand press for small packs. Fresno, California, United States.

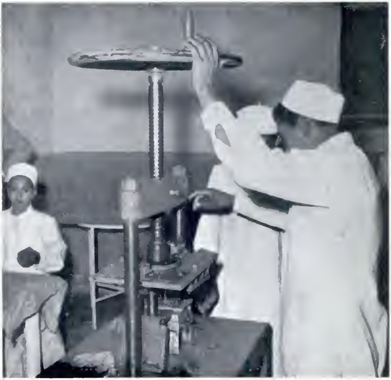

FIGURE 154. – Steel hand press for small blocks of dates. It gives a good, solid block but is slow, whereas a wooden block to be pressed by hand by each packer on the dates in his mold may not give such a solid block but is much quicker. Small rural date-packing house, United Arab Republic.

The machines on the main operations floor, all of which are nowadays driven by electric motor, are best supplied from the roof by cables suspended from plugs. A large number of plugs should be provided when the packing house is built, to simplify alterations in the arrangement of the machines on the floor, necessitated by a change from one treatment to another. Underground cables and standpipes allow less flexibility.

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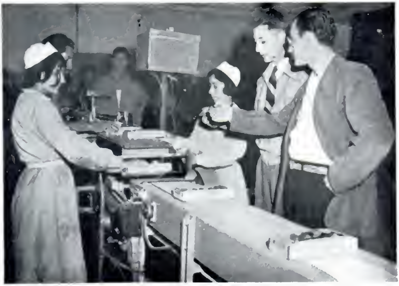

FIGURE 155. – Cellulose film-wrapping machine in production line. Date Association Packing House, Baghdad, Iraq.

FLOOR

A cement floor properly sloped, with ample drainage, is necessary so that it can be washed down easily at the end of every shift. Narrow drains at too gentle a slope become choked with dates, pits and bits of wood. Drains should be covered with gratings to allow for free passage of trucks.

WALLS

Tiling with white tiles.

AIR

The packing season starts in hot weather and continues through cold winters, so that an air system designed to supply both cold and heated air is desirable.

WATER

The water supply must be ample, especially if the dates require much washing. A hot water supply under pressure or steam is necessary for cleaning the machines after each shift. If the machines are not kept clean, the bits of damp dates in the corners will provide nidi for the organisms of fermentation.

FIRE

Suitable emergency exits must be provided and, if the packing house is not on the ground floor, external, steel fire-escape staircases as well.

COSTS

The costs of a date-packing house, as of any plant, are conveniently divided into capital and recurrent. The capital cost will include purchase of land, erection of buildings, making roads, purchase of machinery and equipment, lug (or garden) boxes, land and water transport.

Stallings (1959) found in a representative sample of packing houses in the Coachella Valley that costs were as given in Table 31.

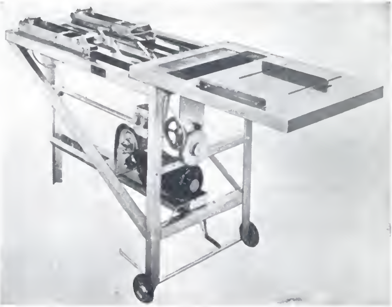

FIGURE 156. – Partly automatic wrapping and heat-sealing machine. Suitable for small output of dates in cartons wrapped in cellulose film. California, United States.

TABLE 31. – Cost per pound for plants packing varying percentages of dates in retail packages, 1956-57

Type of cost	75-90 % (Group 1)	20-74 % (Group 2)	Less than 20 % (Group 3)
		U. S. cents	
OPERATING			
Direct and supervisory labor	2.47	2.39	2.87
Material and supplies	1.74	1.34	1.32
Equipment maintenance and repairs	.28	.13	.13
Equipment depreciation	.36	.18	.21
Plant operating and other costs	.89	.21	.23
Total operating costs	5.74	4.25	4.76
ADMINISTRATIVE			
General	1.08	.43	1
Advertising	.44	.25	0
Selling	1.06	0.	0
Total administrative costs	2.58	.68	1
BUILDING			
Depreciation	.12	.20	.39
Taxes	.18	.15	.17
Maintenance and repairs	.15	.10	.14
Total building costs	.45	.45	.70
GRAND TOTAL	8.77	5.38	[2] 5.46

[1] Based on total quantity of dates received in packing house.

[2] Cost of adiministration not available.

Equipment

The equipment may be divided into packing and miscellaneous equipment.

Packing equipment

Apart from lug boxes, packing equipment consists of the machines and equipment listed on p. 281.

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- Weighing
  - Weighbridge
  - Platform scales (Figure 157)
  - Fork-lift truck or stacking truck with scale attachment
  - Table scales (Figures 158 and 159)
  - Automatic weighing and filling machines
- Handling
  - Trollies
  - Clamp trucks
  - Stacking trucks
  - Fork-lift trucks
  - Roller conveyors (Figure 160)
  - Elevators
  - Belt conveyors
  - Roller track
  - Pallets
- Samplers
- Washers and cleaners
- Graders
- Stools, chairs and tables, packing tables
- Pitters
- Cappers
- Shredders
- Presses
- Slicers
- Mincers (grinders)
- Tray loaders
- Measurers and dosers for preservatives
- Box makers and lidders
- Box syringes
- Fibreboard case staplers (Figures 161 and 162)
- Carton and tray makers-up
- Can makers-up
- Bag makers-up
- Carton, tray, fillers and closers
- Carton, tray, and block wrappers
- Can and jar fillers and sealers
- Can and jar sterilizers
- Tray unloaders
- Drying units
- Pasteurizing units
- Dehydrators
- Hydrators
- Box washers and sterilizers
- Can and jar labellers
- Box fillers
- Stencil cutting machine
- Strappers and wirers
- Measurers and heaters for fumigants
- Hoses and nozzles for cold water, hot water, and steam for washing

Miscellaneous equipment

- Office equipment
- Typewriter, English, French, Arabic, Persian
- Calculating machine
- Filing cabinets
- Office furniture
- Safe, etc.
- Fire equipment
- Tools for mechanic, carpenter and builder

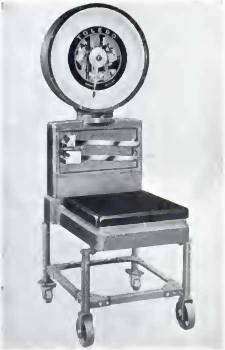

FIGURE 157. – A transportable scale for boxes and bulk packs.

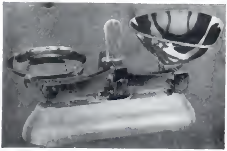

FIGURE 158. – A small scale for weighing loose dates for bag or tray pack. Birmingham, England.

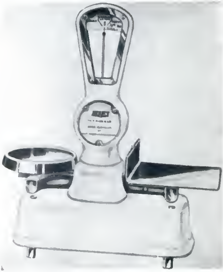

FIGURE 159. – A quick-acting scale for checking the weight of small packs. Birmingham, England.

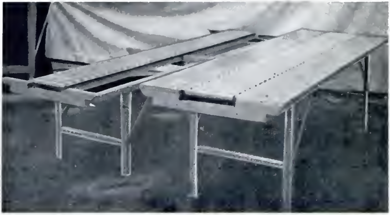

FIGURE 160. – Roller conveyors for use in packing house. Fresno, California, United States.

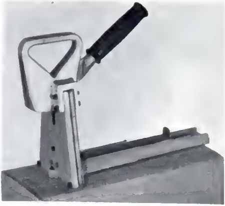

FIGURE 161. – Hand stapler for making and closing fibreboard cases. Copenhagen, Denmark.

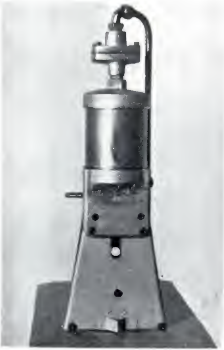

FIGURE 162. – Automatic stapler for making and closing fibreboard cases. Copenhagen, Denmark.

Transport

Most packing houses will need a car and one or more trucks, and those in southern Iraq and Iran usually have their own lighters to collect dates from collecting points and to take the packed dates to the waiting steamers.

Recurrent costs

Overhead

Interest on capital
Depreciation on buildings (about 3%)
Depreciation on water transport (about 5%)
Depreciation on big machines (about 10%)
Depreciation on lug boxes (about 15%)
Depreciation on small machines (about 20 %)
Depreciation on land transport (about 20%)
Rent, state taxes, municipal taxes
Insurance, fire, theft, labor
Light, power, fuel, water, telephone
Maintenance, buildings, machinery, transport, roads
Salaries
Wages of subordinate permanent staff
Office expenses, entertainment, free samples
Annual fees for boiler and scales inspection
Advertisement (if packer is also merchant)

Raw materials

Dates
Date syrup
Corn syrup
Sesame
Almonds
Walnuts
Flavoring essences (vanilla, coumarin, etc.)
Shredded coconut
Citric acid
Chocolate

Packing materials

Bags, cellophane (for loose dates)
" " inner (for block)
" paper, stiff, outer " "
Boxes, cardboard
Boxes, glove (bottoms, tops, sides)
" plastic
" wood
Cans, sealing and lids

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Cans, friction and lids
Cards, backing
" pay
" work record
Cartons
" windows
Cases, fibreboard
Cellophane
Cups, paper, frilled
" carton, waxed
Fumigants, box
" stores
Glue
Iron, baling
Jars, screw-top and lids
Labels, block
Labels, box, glove
" " wooden
" can
" jar
Nails
Paper, colored
" glassine
" kraft
" lace
" plain
Ribbon for fancy packs
Stencil blanks, brushes, ink
Stickers
Trays, carton
Wire, strapping

MISCELLANEOUS EXPENDABLE STORES

To make a complete list of all the expendable articles that have to be bought and kept in the miscellaneous store is not necessary, but the more usual articles are:

- Cleaning materials
  - Soap, detergents, liquid soap, brooms, brushes, dusters, mops, nail brushes, scrapers, squeegees, towels, wire brushes
- Clothes
  - Aprons, bonnets, caps, gum boots, overalls, rubber gloves
- Fly spray
- Lubricants
  - Antirust compound, grease, lubricating oil
- Machine spare parts
- Mechanic's, carpenter's and builder's materials
  - Preservatives

NEED FOR ECONOMY IN PACKING-HOUSE OPERATIONS

In the European and American markets, in Canada, South Africa and Oceania, the date is being subjected to increasing competition from other fruits now being made available for longer seasons than formerly. In

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the countries where dates are grown the standard of living is low and the people are for the most part content with the old field packing. Where the standard of living has risen, as for example by the development of oil resources, there is some welcome in the bigger towns for better packing, but people for the most part spend their newly acquired wealth on new kinds of fruit and food. Consequently, the date-packing house has no easy task to make a profit and its management must pay great attention to organization, the most economical use of labor and machines, and be guided throughout by cost studies of operations, so that unprofitable packs can be discarded. If the cost of labor is rising, so is that of machinery, and labor that can be laid off when the date season ends may be cheaper than machines on which interest and depreciation have to be paid for 12 months in the year. Cold storage and year-round packing, of course, have much to recommend them. The cost of the cold storage determines the practicability of its use.

SALES ORGANIZATION AND ADVERTISEMENT

All packing houses are concerned more or less directly with sales organization and advertisement. Some houses are owned by powerful selling organizations and merely pack to the orders of the controlling sales office. These do not have to allow for advertisement and sales promotion in their costings. At the other end of the scale, there are packing plants run by one man or by a small company in which buying, packing, advertising and selling are all controlled by one office in the plant. Sales promotion then has to be paid for out of the share of the exporter, importer, distributor or wholesaler.

Advertising on the scale necessary to introduce a new brand on an important market is so expensive that only a firm handling a large quantity of a uniform, good-quality, long-keeping product can afford it. The small man, however, without much advertising, but with hard work, can build up a postal order business or develop a special product such as canned date granules or an attractively packed paste flavored with vanilla and containing chopped nuts.

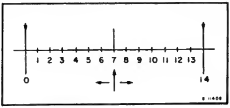
Appendix 1

*p*H VALUE[1]

The acidity in foods not only affects the taste (as when lemon juice, containing citric acid, is used in cooking), or the color (as when vinegar is used to make red cabbage a deep red when cooked instead of purple), but also any chemical changes which are taking place.

An acid taste is caused by hydrogen ions (an ion is an electrically charged atom or atom group) and is proportional to the concentration. The concentration of the hydrogen ions may vary within wide ranges, and it is impracticable to use it as a measure of acidity. The measure in use is the hydrogen exponent, *p*H, defined as the negative logarithm of the hydrogen ion concentration.

GRAPH 1. – SCALE INDICATING THE *p*H VALUE OF ACID, NEUTRAL AND ALKALINE SOLUTIONS



The numerical scale resulting from this definition ranges from 0 to 14 (see Graph 1). The range can be divided into two parts: 0-7: acid range, and 7-14: alkaline range.

The neutral point is 7 (pure water, free from carbon dioxide of the air). From 0 to 7 the acidity decreases in such a way that each number represents an acidity 10 times greater than that of the following number. Thus the acidity at $pH = 2$ is 10 times the acidity at $pH = 3$, and 10,000 times the acidity at $pH = 6$.

---

[1] Prepared by W. H. Barreveld.

Some examples of *p*H values for vegetables and fruits are given below. They are only approximations, because they vary with variety and degree of ripeness.

Apricots	3.2
Apples	3.3
Tomatoes	4.2
Dates	5.6
Peas	6.2
Ripe canned olives	7.0
4 grams pure sodium hydroxyde dissolved in 1 liter distilled water	13
9.6 grams strong hydrochloric acid (38%) diluted to 1 liter	1

For the vegetables and fruits the values are only approximations, because variety and degree of ripeness cause considerable variations.

Two methods are available to determine the *p*H of a solution: the colorimetric, and the electrometric.

The first method requires much less initial expenditure but is not as accurate as the second.

The colorimetric method is based on the property of certain substances to change their color in a *p*H range characteristic for that substance. Some indicators with their color change in the characteristic *p*H range are listed below.

Name of indicator	*Color change*	*p*H *range*
Methyl violet	yellow to blue	0.1–1.5
Thymol blue	red to yellow	1.2–2.8
* Methyl orange	red to orange	3.1–4.4
* Methyl red	red to yellow	4.2–6.3
Bromothymol blue	yellow to blue	6.0–7.6
* Phenol red	yellow to red	6.8–8.4
* Phenolphthalein	colorless to red	8.2–10.0
Salicyl yellow	light yellow to orange brown	10.0–12

---

* Frequently used in chemistry.

Single indicators as described above are used extensively in the chemical laboratory. To measure the *p*H of a solution, a combination of suitable indicators is used, either impregnated in paper or in solution. Brought in contact with the solution of unknown *p*H, the paper or the solution will take on a color, which can be translated into a *p*H value by way of a reference color strip supplied with the paper or solution. Papers covering the whole range from 1 to 13 or narrower ranges, such as 5.7-6.8 or 6.8-8.3 are available according to the specific need.

Below are listed the colors assumed by a universal indicator, that is, one covering a wide range of *p*H values, as the acidity of the solution in which it is used decreases.

*p*H up to 3: yellowish green
” 4 : orangered
” 5 : orange
” 6 : yellow
” 7 : yellowish green
” 8 : greenish blue
” 9 : blue
” 10 : violet
” 11 : reddish

The accuracy is in this case at the best 1 *p*H unit. Papers for narrower ranges have color references down to 0.3 unit apart, but because of the continuous color change through the range, one cannot always expect to reach such accuracy. Colored solutions and very dilute solutions are more difficult to measure.

For measuring the *p*H of a solution more precisely, a *p*H meter is required. As already stated, an ion is an electrically charged atom or atom group. The *p*H meter measures the electrical potential between the hydrogen ions in the solution and a standard electrode.

From the meter scale the *p*H is read off directly. Many types at different prices are available. Those that work on batteries are useful for field work. Common accuracy is 0.1 *p*H unit, more than sufficient for routine work.

It is to be noted that this appendix deals only with the active acidity, i.e., the concentration of the hydrogen ions in foods; but total acidity, which is found by titration and which represents the total concentration of the free acids (acid range) or free alkali (alkaline range), is in most cases not identical with the hydrogen ion concentration.

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Appendix 2

COMPARATIVE TABLES OF SUCROSE AND OTHER CONTENTS FOR PALM JUICE *(Neera)*, SUGAR CANE JUICES, AND THE PALM AND SUGAR CANE GURS

A. Percentage composition of palm and cane juices

Kind of juice	Moisture	Proteins	Fats	Sucrose	Reducing sugars	Minerals	Gums
Palmyra juice	85.89	0.31	0.02	12.20	0.30	0.31	
Wild date palm juice (*P. sylvestris*)	87.63	0.35		11.07	0.96	0.54	0.2 (pectin)
Coconut juice	83.88	0.22	0.04	14.60	0.77	0.26	0.5
Sago palm juice	88.43			9.68	0.075	0.28	0.023
Cane juice	85.66	0.17	0.16 (waxes)	12.34	1.08	0.21	(pectin)

B. Percentage composition of palm and cane gurs

Kind of gur	Moisture	Sucrose	Reducing sugars	Fats	Proteins	Total minerals	Calcium as CaO	Phosphorus as P_2O_5
Palmyra gur	8.61	78.86	1.66	0.19	1.04	3.15	0.861	0.052
Wild date palm gur (*P. sylvestris*)	9.16	72.01	1.48	0.26	1.46	2.60	0.363	0.52
Coconut palm gur	10.32	71.89	3.70	0.15	0.96	5.04	1.638	0.062
Sago palm gur	9.16	84.31	0.53	0.11	2.28	3.66	1.352	1.372
Cane gur	6.94	69.43	21.18	0.05	0.25	1.00	0.4	0.045

From *The Indian Sugar Industry* (1954-55), Vol. 18, February 1956.

Appendix 3 A

NAMES OF DATES IN THEIR STAGES OF DEVELOPMENT IN DIFFERENT COUNTRIES

Country or province	Hababauk	Kimri	Khalaal	Rutab	Tamar	Mummified	Dates generally
PAKISTAN							
Punjab		Khamal	Doka				Khajuur Khurma Khajji
Muzaffargarh		Gandora		Dang (50%) Pend (100%)	Pend, Sukki Pend, Khurma	Kuk Kukan	
Sind Makran		Pappuk	Chuwarar Rang, Kulont		Khurma		
Kech Panjgur					Na Hurmag		
IRAN							
Shatt el-Arab	Hababauk	Chimri	Khalaal	Rutab	Tamar	Abul Khusheim	Tamar
IRAQ	Hababauk	Chimri	Khalaal	Rutab	Tamar	Abul Khusheim (Hallaawi) Chasib (Zahdi, Ashrasi, etc.)	Tamar
SAUDI ARABIA							
Hasa	Habambuk, Durra	Khalaal	Bisir	Rutab	Tamar		Tamar
Hejaz		Sadi	Balah	Rutab	Tamar		
BAHREIN	Hababau	Khalaal, Jimri	Bisir	Rutab	Tamar		Tamar
MUSCAT AND OMAN							
Dhufaar	Ankariiz	Khalaal	Bisir	Rutab	Suhh		Tamar, Sahh

ADEN PROTECTORATE							
Hadhramaut	Dhubdhub	Naqadh	Fadha	Wasam (50%) Qara (100%) Rutab	Tamar		Tamar
SOMALIA			Khariif				
YEMEN				Munaasif(50%) Bint (100%) el-Baariha			
SUDAN		Dufeiq					
LIBYA							
Coast		Ghamag	Bisir, Balah Safar	Rutab	Tamar	Ariish	Tamar
Taworgha		Farzuum					
Ghadames (Targi)	Indhuukan	Aagingin	Teiraghi	Uugda	[1] Teini		
" (Berber)				Amashhaut	[2] Aveina		
Ghat							
Kufra (Teda)		Arsa	Qudar	Tulei	Tine		Tine
NIGER			Tuli		Tinni Timmi	Bidi	Tinni
TUNISIA		Aghmag	Balah		Tamar		Tamar
ALGERIA			Balah (Blah)	Maratba or Martuuba		Frezza	
MOROCCO							Abluuh
SPAIN		Verde	Grogs		Maduros Negros	Candios	
UNITED ARAB REPUBLIC			Balah Niiruz Balah Bisir Asfar Ahmar	Rutab Balah Rutab	Tamar	Balah Naashif	Balah
UNITED STATES		Kimri	Khalaal	Rutab	Tamar	Putty-Ended (Hallaawi) Mummified (Daglat Nuur)	Dates

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[1] Teini (singular, ahaggaariiyan).

[2] Veinaawan (singular, aveina).

Appendix 3 B

NAMES OF PARTS OF THE DATE PALM IN ENGLISH, FRENCH, AND IN FOUR LANGUAGES USED NORTH OF LAKE CHAD *

English	French	Kanembou [1]	Dazaga [2]	Arabic (Chad dialect)	Teda [3]
1. Palm grove	Palmeraie	Sara	Tima	Djenane	Tanni Ouanou
2. Date palm	Palmier	Oualé	Timi	Tamar	Tinné
3. „ „ (female)	„ (femelle)	Oualé Kouroudi	—	—	—
4. „ „ (male)	„ (mâle)	Oualé bi	—	—	—
5. Trunk	Tronc	Balto	Eguini	Kachabe	Tenni iedé
6. Crown on fronds	Ensemble des palmes	—	Daràa	Djerid	Tuni cuji
7. Frond	Palme	Dinné	Dri	Djerida	Tuni tro – dère – dire
8. „ base	Base des palmes	—	Emboubou	Kirnaf	Forra – arfo
9. „ midrib	Nervure de palme	—	Koudou	—	Temidjeri – Tumuzeri
10. Spine	Epine	—	Hellé (s) Hella (p)	Chouka	Soumeri Herro
11. Leaflet	Foliole	—	Doussou (s) Doussa (p)	Zaaf	Doussa – doussa
12. Bunch (of dates)	Régime	Oualé	Tongoum	Arjoun	Mouzi
13. Main stalk of bunch	Hampe de régime	—	Engaï	Cif	Sosé – Anaa
14. Spikelet	Brin de régime	—	Brisi	Charchouti	Hangué
15. Spathe	Enveloppe de régime	—	Engaï oui	—	Sogné

16. Male flower	Fleur mâle	—	Dor	Oubra	Domar
17. Female flower	„ femelle	—	—	—	Founi
18. Terminal bud	Bourgeon terminal	—	Agom	Galibe	Aba – arsanane
19. Fiber	Fibre	—	Mouzou-Liff	Liff	For
20. Offshoot	Rejet	Ouali oulé	Dou	Rharsa	Toteno (s) Totena (p)
21. High offshoot	Gourmand	Tolkoun	Tourkoune	Firae	Forfogoma
22. Root	Racine	—	Djoubou	Ourougue	Tenno (s) Tenna (p)
23. Date	Datte	(ripe) Dinou (green) Ouali	Timi (s) Tima (p)	Tamra (s) Tamar (p)	Tenni
24. Date stone	Noyau de la datte	n'gour	Keou (s) Kaoua (p)	Nouaya	Kobou-kobo
25. Flesh	Chair	—	Fade	—	Kommar
26. Skin	Peau	—	Tchore	Guichera	Tchor
27. Perianth	Cupule	—	Kohor	Marafa	Kouadanou
28. Seedless date	Datte sans noyau	—	Chiddi	—	Tourkoui
29. Date mite cob-web	Acariose des dattes	—	Dorgossa (dust) Bedidé	Rorbar (dust)	Arma-Kotchiné (dust)
30. Palm sap (unfermented)	Sève du palmier non fermentée	Merisé	Agachi	—	—
31. Palm sap (fermented)	Sève du palmier fermentée	—	Arigui	—	—

NOTE: Pronunciation of the African terms should approximate the French.

[*] Prepared by P. Munier.

[1] Kanembou : Dialect of Kanem, northeast of Lake Chad.

[2] Dazaga : Dialect of the Goranes (Tibus from south of the Tibesti mountains).

[3] Teda : Dialect of the Tibus.

Appendix 4

EQUILIBRIUM MOISTURE CONTENT CURVE[1]

The dryness of the air can be expressed in figures, and the unit usually adopted is the " percentage relative humidity, " i. e., the amount of moisture in the air at a certain temperature, expressed as the percentage of the amount of water it would contain if fully saturated at that temperature. For instance, on a dry, warm, sunny day in England, the air is seldom less than 60 percent relative humidity at, say, 27° C., whereas the dry hot wind coming from the Sahara often brings the relative humidity of North Africa down to 10 percent or less.

The percentage humidity is easily measured by means of the wet and dry bulb thermometer, the difference between the temperatures shown on the two thermometers giving a measure of the humidity. If the two readings are about the same, the air is saturated, i.e., 100 percent R. H. (relative humidity). If the air is dry, there will be a difference of many degrees, and the drier the air, the greater is the difference.

It is well known that in a humid atmosphere, dates of low moisture content, especially when they are cut in half, will absorb moisture from the air. Inversely, moist dates will give off moisture in dry air.

With whole dates the process of exchange of moisture is slow, due to the natural impermeability of the skin. Dates stored whole will therefore adapt themselves slowly to the humidity of the surrounding air. The process is quicker with halved dates, because the flesh is exposed.

Equilibrium moisture content curve

In what direction and to what extent a change will ultimately occur can be predicted with the help of an equilibrium moisture content curve. Such a curve shows graphically by means of a diagram the relation between the relative humidity in the air and the moisture content of the dates, both expressed as percentages. This curve can be determined experimentally in different ways, but it must be recognized that a curve is only valid for one particular product or variety, at one particular temperature, although in general the influence of temperature is small, at least in the range of 20° to 35° C. However, further studies on the influence of temperature will have to be made. The curve shown in Graph 2 indicates one point of equilibrium (marked x) that was determined at 35° C., which differs very little from the point determined at 20° C.

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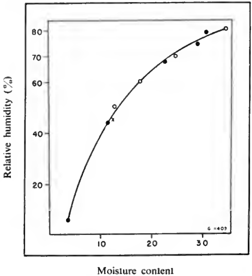
[1] Prepared by W. H. Barreveld.

Graph 2. – Equilibrium moisture content curve for Bikraari dates (20°C.)



- Libyan dates (20° C.)

× " " (35° C.) Barreveld, 1959

○ California dates
invert type (24° C.) Rygg, 1948

The determination of this curve was carried out by mixing a known quantity of minced Bikraari dates with very fine sand in order to facilitate moisture exchange from the material to the surrounding air.

The sample in duplicate was weighed and placed in a desiccator in which a certain relative humidity was created, derived from a specific, saturated,

Details of equilibrium obtained

	Sample	Wet weight gm.	Dry weight gm.	Percentage of moisture on wet basis	Moisture ratio
Original sample	I	14.6640	11.7879	19.61	0.244
	II	18.6140	14.9473	19.69	0.245
In equilibrium with saturated solution of:					
NH_4Cl	I	17.1377	11.7879	31.22	0.454
(79 % R.H.)	II	21.7350	14.9473	31.23	0.454
NaCl	I	16.6609	11.7879	29.25	0.413
(75 % R.H.)	II	21.1553	14.9473	29.34	0.415
1 NaCl 68 %	I	15.3267	11.7879	23.08	0.300
6 Sucrose R.H.	II	19.3715	14.9473	22.84	0.296
K_2CO_3	I	13.3342	11.7879	11.59	0.131
(44 % R.H.)	II	16.9132	14.9473	11.62	0.131
NaOH	I	12.2374	11.7879	3.68	0.038
(6 % R.H.)	II	15.5372	14.9473	3.79	0.039

salt solution. A little fan inside the desiccator circulated the air to speed up the process of moisture exchange. The temperature for this experiment was kept at 20° C. At intervals the samples were weighed and, when it was found that the weight did not change any more, the equilibrium for this particular saturated salt solution was reached. Then another saturated salt solution producing a different relative humidity was used and the procedure repeated.

In the course of five months, five different points of equilibrium were obtained, the particulars being given above.

As a next step, the relative humidity and the moisture content (on wet basis) in percentages, are plotted in Graph 2 and a smooth curve is drawn through these points. It will be observed that the equilibrium at 79 percent relative humidity is a little outside the curve, probably because this point of equilibrium was reached by adsorption, while the other points were reached by desorption. It is known from other materials that sometimes a distinction must be made between adsorption and desorption equilibrium moisture content. Therefore, more value is attached to the relation at 75 percent than at 79 percent relative humidity and the curve is drawn accordingly.

For comparison also a few points (marked 0) are given in the curve, which were found by Rygg in 1948 and are an average for eight varieties of Californian invert sugar dates (temperature 24° C.). No conclusions can be drawn from the comparison because the varieties in the two sets of experiments were different from each other, but it is interesting to note that there is much similarity in the two curves.

Practical use of the equilibrium moisture content curve

There are several uses for such a curve, for instance, determination of safe moisture content for storage, relative humidities during storage, and the requirements for dehydration.

SAFE MOISTURE CONTENT

It is known that molds are unable to grow in an atmosphere in which the relative humidity is lower than approximately 70 percent, while for yeasts and bacteria even higher levels of humidity are required.

Graph 2 shows that 70 percent relative humidity is reached at a moisture content of 24 percent. Therefore, below this percentage there need be no fear of mold growth. However, wet pockets may occur and cause severe damage, although the bulk of the product may have the right moisture content. The molds will start to grow in these wet spots and the water generated in this process will result in an increased water content of the surroundings, enabling further development of molds.

RELATIVE HUMIDITIES DURING STORAGE

It is easy to calculate humidity levels at which dates with a certain moisture content can best be stored, so that there is neither gain nor loss in moisture content, and it remains in equilibrium with the surrounding air once the humidity in store is known.

DEHYDRATION

The equilibrium moisture content curve is a very useful aid in calculating the necessary conditions for artificial dehydration.

Appendix 5

MOISTURE DETERMINATION IN DATES BY MEANS OF A REFRACTOMETER [1]

The procedure for using a hand refractometer in the packing house is as follows:

1. Prepare the date material for testing by passing it through a small food mincer equipped with a fine cutter and mix the paste that is produced.

2. Apply a smear of uniform thickness on the inner face of the cover of the refractometer and press the cover firmly against the glass prism.

3. Read the temperature correction on the built-in thermometer.

4. Read the percentage of solids in the sample by looking through the exit pupil of the instrument into somewhat diffused light. The line of demarcation between the light and the dark portion of the field indicates the percentage of solids as shown on the scale.

5. Apply the correction noted in (3) to the reading obtained in (4).

6. Subtract the value obtained in (5) from 100 to get the percentage of moisture.

7. Apply the variety correction given below; the result is the percentage of moisture in the sample.

Correction factors

The following correction factors have to be applied to values for moisture content of dates as determined with the refractometer:

---

[1] Adapted from Rygg, 1945.

Variety	*Correction*
Daglat Nuur	-1.4
Dayri	-1.4
Zahdi	-1.3
Khadhraawi	-1.2
Hallaawi	-1.2
Saidi	-1.1
Majhuul	-1.0
Maktuum	-0.7
Barhi	-0.3

The date smear is applied to the surface opposite the polished glass rather than directly to this glass to avoid scratching the highly polished surface. This glass is relatively soft, and the operator cannot be cautioned too strongly against scratching it. Grit should be removed from the surface of the dates before the sample is prepared, and the operator should avoid allowing the fingernails to touch the glass. The instrument may be cleaned by holding the prism end under a water tap and carefully removing the date material. The main part of the instrument must not be placed in water, as moisture must not be permitted to enter the interior. Hot water must not be used, but warm water is permissible if the instrument is allowed to cool before the next determination is made. Dry the instrument with a clean, soft, absorbent cloth. General operating instructions are provided with each instrument by the manufacturer.

Appendix 6

MOISTURE DETERMINATION IN DATES [1]

Bidwell and Sterling method

A weighed sample of dates (20-25 grams, when a 10-milliliter receiver is used) is placed in an Erlenmeyer flask (300-500 milliliters) well covered with toluene (Graph 3). A Dean and Stark type receiver is tightly attached to the flask.

Toluene ($C_6H_5CH_3$) is not miscible with water, boils at 111°C. and has a specific gravity of 0.864 at 20°C.

When the toluene is heated to boiling point, the water present in the date will be transformed into vapor and will evaporate together with a certain amount of toluene vapor. Both components are then condensed in the cooler from which they trickle back into the receiver. Due to the fact that the two liquids are not miscible and water has a higher specific gravity than toluene, the water droplets fall to the bottom of the receiver, while the excess of toluene flows back to the flask, where it eventually will be evaporated again together with a new quantity of water.

The process continues till all moisture from the sample has been transferred to the receiver. The end of the process can best be determined by watching the condensed liquid. If there are still water droplets falling to the bottom of the receiver, they can be easily distinguished.

The receiver is cooled to room temperature when the end of the process is reached and the volume of water measured. This measurement divided by the weight of the original sample, multiplied by 100, equals the percentage of moisture in the original sample.

The distilling method is useful when quick results are required. Although in principle the total amount of moisture in the date sample is measured, there are two disturbing factors which influence the final result and make it necessary to standardize the procedure and calibrate the result with the vacuum oven method.

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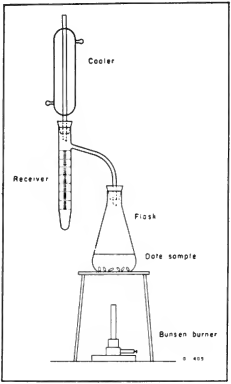
[1] Prepared by W. H. Barreveld.

GRAPH 3. – EQUIPMENT FOR THE DETERMINATION OF MOISTURE IN DATES AND OTHER AGRICULTURAL PRODUCTS



As an illustrative sample, some figures are given below (distilling time for all samples, 90 minutes).

	Water produced	*Moisture by vacuum oven*
(*a*) Toluene only	nil	–
(*d*) Distilled water	94–98 %	–
(*c*) Fructose (dry)	10.9 „	–
(*d*) Glucose (dry)	nil	
(*e*) Date sample A	17 %	17.3 %
„ „ B	17.7 „	17.9 „

It will be seen that decomposition of fructose, whereby water is formed, ends to increase the final outcome, although the decomposition of the fructose in the date does not necessarily have to reach the same degree as the pure sample mentioned under (*c*).

A too low final result can be caused when all the moisture is not collected in the lower part of the receiver. Drops of water tend to stick to the glass in the upper part. With a thin glass rod or brush, saturated with toluene, the major part of these droplets can be worked down.

The two counteracting factors, depending on their magnitude in the adopted circumstances, will result in a plus or minus correction factor. It is for these reasons that it is recommended to calibrate the method with the vacuum oven technique.

Glassware should be clean and dry or well rinsed with toluene before use. Toluene is inflammable and care should be taken to extinguish the Bunsen burner before opening the apparatus.

(For further detailed information see *Official methods of analysis of the Association of Official Agricultural Chemists*, published by the Association of Official Agricultural Chemists, P. O. Box 540, Benjamin Franklin Station, Washington 4, D.C., U.S.A., 8th ed., 1955.)

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MOISTURE DETERMINATION IN DATES[1]

Vacuum oven method

The most direct method of determining the moisture content in a sample of dates is to drive off moisture by heat.

When the usual drying stove temperature of 105°C. is employed, chemical changes occur in the dry material, causing a distorted final result. The main cause for these changes is almost certainly the decomposition of fructose. For this reason no temperatures over 70°C. and preferably 65°C., should be employed. At atmospheric conditions (760 millimeters mercury) complete drying would take very long. To shorten this time, a vacuum oven is normally used.

The pressure around the samples is reduced to 40-60 millimeters mercury, thus speeding up drying considerably. However, the total time required is long and the method is not appropriate for quick control work.

Graph 4 shows two samples of dates, for which two drying curves have been established. In the first six hours of drying, more than 90 percent of the total moisture is driven out. After this period the drying rate falls sharply but never reaches zero. The last traces of moisture are very strongly bound to the material, which is rich in sugar, and even at these lower temperature levels some changes occur in the dry substance. It seems, therefore, that the vacuum oven method does not provide the " absolute " moisture determination. However, since on average less than 0.1 percent moisture per 24 hours is added after drying for 48 hours, and this is partly due to chemical changes, it is evident that the vacuum oven method gives a result close enough to the absolute moisture content for practical purposes.

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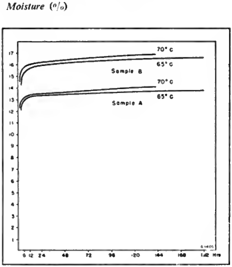
[1] Prepared by W. H. Barreveld.

GRAPH 4. – DRYING CURVES OF TWO SAMPLES OF DATES AT 65° AND 70° C.



For comparative studies it is necessary to state the temperature, vacuum and length of drying employed. No uniform rule has been adopted for dates, and a few recommendations are given below.

Source	*Temperature*	*Pressure*	*Drying time (hours)*
Rygg (1948)	65° C.	not stated	48
Schiller and Maier (1958)	70° C.	not exceeding 75 mm.	20
Date laboratory (Tripoli)	65° C.	not exceeding 60 mm.	48

Sometimes reference is found to the drying of samples until two consecutive weighings at a two-hour interval do not differ by more than 2 milligrams. Compared with Graph 4 this will happen after about 48 hours of drying (65° C., 5-gram sample).

The equipment to effect moisture determination in vacuum is listed below:

1. A hand-operated mincer.
2. An analytical balance (accuracy 0.1 milligram).
3. A vacuum oven equipped with a thermostat, thermometer and vacuum gauge.
4. Drying tower, filled with silica-gel to absorb the removed moisture.
5. A vacuum pump with motor.
6. A desiccator with a suitable desiccating material (silica-gel or calcium chloride).
7. Aluminium dishes about 6 centimeters in diameter and tight-fitting covers.

The sample to be examined is passed twice through the mincer, care being taken that it is exposed to the air for the shortest time possible. About 5 grams are taken and flattened on the bottom of the dish. In this way a good contact with the heating surface of the oven is secured.

After the sample has been dried for the required time, the dish is cooled in the desiccator (half an hour is usually sufficient) and weighed again.

The difference in weight before and after drying divided by the weight of the original sample, multiplied by 100, gives the percentage of moisture (on wet basis).

It is not a good practice to put fresh samples in the oven together with others already nearing the drying point.

(For further detailed information see *Official methods of analysis of the Association of Official Agricultural Chemists*, published by the Association of Official Agricultural Chemists, P. O. Box 540, Benjamin Franklin Station, Washington 4, D. C., U.S.A., 8th ed., 1955.)

Appendix 8

ANALYSIS OF SUGAR IN DATES[1]

Graph 5 shows the date flesh broken down into those components that are of importance to the date packer. The degree of importance depends rather on the purpose for which the date is examined. For instance, as has been mentioned previously, the ratio of sucrose to reducing sugars is probably related to hardness in the later stages of ripening. But the date syrup manufacturer will be specially interested in the total soluble material, and when the syrup is manufactured on an industrial scale, also in the proportions in which the three sugars are present.

The approximate percentages by weight of the different components have been put in parentheses in the diagram; they are based on a moisture percentage of 20. The sugars are by far the biggest single constituent and this appendix is devoted to their quantitative determination.

The best way to do simple and quick sugar determinations is by the use of a refractometer with a filtered, clarified date solution.

If an exact percentage of the total sugars, or of the individual sugars, is required, then the more complicated chemical and physical (i.e., polarimetric) methods have to be used. The two methods are based on different principles, but they have in common the fact that the directions for analysis must be observed very accurately in order to arrive at dependable results.

It would be impossible to describe here all the available methods and instructions for their use. The following pages can only be an introduction to this subject, for which the details can be found in such standard works as: G. L. Spencer and G. P. Meade, *Cane sugar handbook ;* P. Honig, *Principles of sugar technology* ; and the *Official methods of analysis of the Association of Official Agricultural Chemists.*

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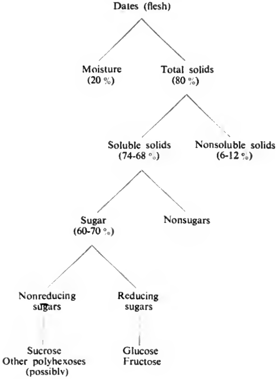
[1] Prepared by W. H. Barreveld.

GRAPH 5. – ANALYSIS OF SUGAR IN DATES



The chemical methods

The chemical determinations of the reducing sugars (i.e., glucose and fructose) are for the greater part based on the property of these sugars of reducing copper in the cupric state to cuprous oxide. Under specified conditions, the amount of reduced copper is a measure for the quantity of reducing sugars. The sucrose present is not affected. In order to include this sugar also in the total amount, the sucrose is first inverted, after which the sugar content is again determined. The difference in quantities found before and after inversion, multiplied by 0.95, equals the sucrose content.

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The factor 0.95 is easily understood when the inversion formula is considered:

$$\begin{array}{llll}
C_{12}H_{22}O_{11} & + H_2O & = C_6H_{12}O_6 & + C_6H_{12}O_6 \\
\text{Sucrose} & + \text{water} & = \text{glucose} & + \text{fructose} \\
\text{Molecular weight } 342 & + 18 & = 180 & + 180
\end{array}$$

Out of 342 grams sucrose, 360 grams reducing sugars are formed, hence the factor 0.95.

PREPARATION OF THE SAMPLE

In all, 25 milliliter solution containing between 25 and 40 milligrams of reducing sugars are required (Luff-Schoorl method). Although this concentration can always be reached by dilution, this step can be avoided when the sample weight is correctly chosen. The following procedure is taken for a common case, dates containing 60 to 70 percent reducing sugars and a small percentage of sucrose.

Ten grams of a well-minced sample is dissolved in warm water in a ½-liter measuring flask. After cooling, water is then added up to the mark. The nonsoluble matter will collect at the bottom of the flask, but the error caused by its volume is negligible. Fifty milliliters of the solution is pipetted in a 100-milliliter measuring flask (Solution I).

CLARIFICATION

The next step is to free the solution from substances which may interfere with the actual sugar determination. Clarification can be accomplished in several ways. The general properties of an adequate clarifying agent are:

(*a*) It should be effective in small quantities to avoid excessive dilution of the sample.

(*b*) It should precipitate completely the foreign matter, leaving the sugars untouched.

(*c*) It should not interfere with the subsequent chemical determination.

(*d*) The excess of the clarifying agent should be easily removed by a suitable reagent, if condition (*c*) cannot be fulfilled.

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A suitable clarifying agent for a date solution is neutral lead acetate (not basic, because this affects the fructose), followed by mono sodium phosphate as a de-leading agent.

The procedure is as follows: A 10-percent lead acetate solution is carefully added to Solution I until precipitation ceases. The flask is filled to volume and the solution filtered through a dry filter, discarding the first few milliliters. Fifty milliliters of the filtrate are pipetted into a 100-milliliter measuring flask and so much saturated mono sodium phosphate solution added, until all excess lead is precipitated. The flask is filled up to the mark and the solution filtered again. The filtrate (Solution II) is kept in a closed bottle for determination. It now contains about 325 mg./100 ml. reducing sugars.

SUGAR DETERMINATION

There are many different methods, and modifications of methods, of sugar determination and several of them are suitable for dates. One of these, the Luff-Schoorl method, is outlined below as an example.

Twenty-five milliliters of Luff solution (the composition is given in the directions for this method) is added to an amount of the sample solution (II) containing 25 to 40 milligrams of reducing sugars. In the present case, 10 milliliters would have been taken (10/100 × 325 = 325 mg.). The total volume of liquid is made up to 50 milliliters with distilled water (in this case 15 milliters). A few pumice stones are added and the liquid is boiled exactly in the prescribed way.

In addition to this determination, a control test (25 milliliters of Luff solution plus 25 milliliters distilled water) is also done.

After boiling, the liquid is quickly cooled and treated with 3 milliliters of potassium iodide (1 normal), 20 milliliters hydrochloric acid (25 percent) and 10 milliliters potassium sulfur cyanide (20 percent). The solution is then titrated with a 0.1 normal sodium thiosulfate solution with soluble starch as indicator.

The difference between the amount of thiosulfate used for the control test and that used for the sugar solution is a measure for the sugar content. The amount of sugar can be found by way of a reference table, usually supplied with the directions. The total amount of reducing sugars in the original 10-gram sample can then be calculated.

INVERSION OF SUCROSE

For determination of the total amount of sugars the sucrose has to be converted into reducing sugar by way of inversion. This can be accomplished by the addition of invertase (an enzyme) or an acid. The latter is most commonly used and one of the methods is outlined below.

Fifty milliliters of the prepared Solution II is placed in a 100-milliliter flask. Five milliliters hydrochloric acid (30%) is added. A thermometer is inserted and the flask is put in a waterbath of 70°C. When the temperature inside the flask has reached 67.5°C., the process is continued for exactly ten minutes. The flask is then quickly cooled to 20°C. The thermometer is removed and the solution is neutralized with 8 milliliters 0.5 normal sodium hydroxide (methyl orange as indicator). The sugar determination is then carried out as described above. Because of the extra dilution, a 20- instead of 10-milliliter sample is taken.

The amount of sucrose is found by multiplying the difference before and after inversion by 0.95, as described previously.

Although the reducing sugars in the date are formed in equimolecular proportions, it cannot be taken for granted that glucose and fructose remain in equal proportions. If a determination of the individual glucose and fructose is required, then a separate chemical analysis has to be performed. It is also possible to find the individual proportions of sucrose, glucose and fructose by doing a combined chemical and polarimetric determination.

To conclude the description of the chemical sugar analyses, it should be noted that a slightly inaccurate result can be caused by the nonfermentable reducing substances. These are likely to be decomposition products of sugar which have lost the specific sugar properties but not their reducing power. In detailed chemical analyses these components can also be determined separately. In that case, the reducing sugars are first fermented with a yeast solution. A second disturbing factor is the possible presence of other polyhexoses near to sucrose. No study on this subject seems to have been made for dates but the influence on the final result is likely to be small.

The polarimetric method

The determination of sugars with a polarimeter (called saccharimeter when it is specially equipped for the determination of sugars) is based on the property of " optical active " reagents, to which the sugars belong, to rotate the plane of polarized light. The rotation is called negative when the angle of rotations is to the left and positive when it is to the right.

Each sugar has its own specific power to rotate the plane of polarized light. By definition, the angle of rotation through 100 millimeters of a 100 percent (1 gram per 1 milliliter) solution of the pure substances is called its specific rotation. As this magnitude (α) varies with the wavelength and the temperature at which the measurement is made, these must be specified. The temperature of 20°C., and the light of a sodium lamp (D-line, 589.25 mμ) are most commonly found. For example, for sucrose $(\alpha)_{D}^{20°C.} = +66.529°$ (angular degrees).

The specific rotation is the basis for the calculation of the concentration of unknown solutions with one component, making use of the equation:

$$c = \frac{100}{(\alpha)_{\lambda}^{t} \cdot 1}, \text{ in which:}$$

c = concentration of substance expressed in grams per 100 milliliters

α = polarimeter reading in angular degrees at temperature t and wavelength λ

$(\alpha)_{\lambda}^{t}$ = specific rotation of the substance at temperature t and wavelength λ

1 = length of tube in decimeters

For a quicker procedure, special saccharimeters have been developed for the sugar industry.

The scale of Ventzke, which is divided in 100 parts (degrees Ventzke) is commonly used. A rotation of 100°V. is obtained when a solution of 26.000 grams pure sucrose (the so-called normal weight), dissolved in 100 milliliters of water, is polarized in sodium light at 20°C. in a tube of 2-decimeter length.

Supposing the reading of an unknown solution is 15° V., then the concentration is $\frac{15}{100} \times 26.000 = 3.9$ grams per 100 milliliters.

Basically there is no difference between this and the general formula given earlier, but the Ventzke scale makes the calculation less complicated.

In date solutions in which three sugars are present in unknown quantities, the use of the polarimeter is restricted to the determination of sucrose only. However, when the total sugar content (after inversion) is determined chemically, then with the additional polarimeter readings all three sugars can be determined.

The sucrose determination with the polarimeter, widely used in the sugar industry, was first standardized by Clerget in 1846 and later modified by Herzfeld. Preparation of the sample, clarification and inversion, are very much the same as those used for the chemical method.

The principle of the determination is based on the fact that the difference in the angle of rotation before and after inversion is caused by the sucrose present in the solution. The following formula is applied:

$$Z = \frac{100\ S}{142.66 - \frac{1}{2}\,t}, \text{ in which:}$$

Z = concentration of the sucrose expressed in grams per 100 milliliters

S = difference in reading, before and after inversion

t = temperature in °C. of the liquid after inversion

Several improvements to the above formula have been introduced, but it would lead too far to describe them all. Suffice it to say that the different modifications are for eliminating certain disturbing side effects. For instance, the factor 142.66 as indicated in the above equation varies somewhat with the concentration of the sample. Another side effect is the influence of the hydrochloric acid on the power of polarization of fructose. For additional details, reference is made to the literature cited.

(For further detailed information, see *Official methods of analysis of the Association of Official Agricultural Chemists*, published by the Association of Official Agricultural Chemists, P.O. Box 540, Benjamin Franklin Station, Washington 4, D. C., U.S.A., 8th ed., 1955.)

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RELATIONSHIP BETWEEN SPECIFIC GRAVITY AND MATURITY IN HAIYAANI DATES IN THE *KHALAAL* STAGE

	Constituent	Percentage						
		floating on						sunk in
		distilled water	2 % NaCl	4 % NaCl	6 % NaCl	8 % NaCl	10 % NaCl	10 % NaCl
WET WEIGHT	Dry matter	24.4	27.1	29.2	30.2	32.4	34.5	39.4
	Reducing sugar	6.1	6.2	6.1	5.9	6.1	6.3	6.3
	Sucrose	5.0	7.2	8.8	9.5	12.4	15.8	17.7
	Total sugars	11.1	13.4	14.9	15.4	18.5	22.1	24.0
DRY WEIGHT	Sucrose	20.6	26.6	30.3	31.3	38.2	45.8	45.1
	Total sugars	45.7	49.5	51.3	51.0	57.0	64.1	61.0

(NaCl, sodium chloride or common salt)

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Appendix 10

ANALYTICAL DATA OF SOME OF THE CONSTITUENTS OF THE DATE PIT

Fatty acids present

Capric acid	0.7 %
Caprinic "	0.5 "
Lauric "	24.2 "
Myristic "	9.3 "
Palmitic "	9.9 "
Oleic and linoleic acid	52.2 "
Stearic acid	3.2 "

(From: Commercial Laboratory, 1960)

Analysis of the date pit

Moisture	6.46 %	7.7 %
Oils	8.49 "	8.8 "
Proteins	5.22 "	
Carbohydrates	62.51 "	
Fibers	16.20 "	
Ash	1.12 "	
Fatty acids of oil		1.3 %
Iodine number		56.3 "
	(From: Iraq, 1958)	(From: Commercial Laboratory, 1960)

Further characteristics of date pit oil

Specific weight at 15.5 °C.	0.9207	0.91985
Refraction index at 40 °C.	1.4580	–
Refraction value (Zeiss) at 25 °C.	–	58
Saponification value	208.3	260

Iodine number	53.0	–
” ” (Hanus)	–	65
Reichert-Meissl number	1.1	1.50
Polenske value	2.9	2.50
Acid value	0.6	–
Acid value in milligrams KOH for 1 gram of oil	–	1.0098
Free acidity expressed as oleic acid	–	0.50 %
Unsaponifiable matter	0.40%	1.28 „
(*a*)		(*b*)

(*a*) From: *Vegetable fats and oils*, by G. S. Jamieson, 1943.

(*b*) From: Stazione Chimico-Agraria Sperimentale, Rome, April 1955.

Appendix 11

GRAPHICAL REPRESENTATION OF THE ACTIVITIES IN A DATE-PACKING HOUSE[1]

Simple method to determine the required storage space

A graphic representation facilitates the determination of the storage requirements at any moment and also the calculation of the maximum storage space needed.

The required storage space at any moment is governed by the accumulated amount of incoming dates (line X in Graph 6), less the accumulated amount of dates sold (line Y), while the sales capacity is limited by the processing and packing capacity of the packing house (line Z).

In the graph the vertical axis (ordinate) indicates the amount of dates usually expressed in tons. The horizontal axis (abscissa) gives the number of days, taken from the day the first dates come in. Therefore: (*a*) Line X represents the total quantity of dates brought in after a certain number of days. Example: Point " a " in the graph shows that after 20 days 250 tons were brought in. (*b*) Line Y represents the total amount of dates sold after a certain period. Example: Point " b " in the graph shows that after 20 days the sales have amounted to 85 tons. (*c*) Line Z gives the total amount of processed and packed dates. Example: Point " c " in the graph shows that after 20 days 150 tons were processed and packed.

For any specific day the graph also indicates:

1. The amount of dates in stock, both processed and unprocessed, indicated by the distance a-b, i. e., in this case 250-85 = 165 tons.

2. The amount of unprocessed dates in stock, shown by the distance a-c, in this case 250-150 = 100.

3. The amount ready for sale, being the distance c-b, in this case 150-85 = 65 tons.

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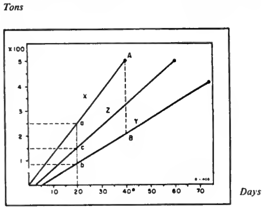
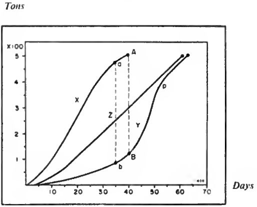
[1] Prepared by W. H. Barreveld.

GRAPH 6. – STORAGE REQUIREMENTS IN THE DATE-PACKING HOUSE



X = Incoming dates
Y = Sales
Z = Production

GRAPH 7. - EXAMPLE OF GRAPHICAL INTERPRETATION OF ACTIVITIES IN A 500-TON DATE-PACKING HOUSE



X Incoming dates
Y Sales
Z Production

MAXIMUM STORAGE

The maximum storage requirement is given by the maximum length of the vertical difference between line X and line Y, i.e., the distance A-B.

Example: AB = 500-210 = 290 tons.

The graph has been kept simple in order to explain the basic concept. Therefore, two assumptions had to be made:

1. The day-to-day activity was constant during the whole season, therefore the lines are straight.

Naturally there will always be some uncertainty in the prediction of the outturn and expected sales possibilities. However, it is the duty of management to make this uncertainty as small as possible.

2. The storage space required for the finished product is materially the same as for incoming dates. If this is not the case, then volume in cubic meters, instead of weight in tons, can be put on the vertical axis of the graph.

Graphic interpretation of the activities

It is also useful to plot the day-to-day activities of the packing house during the season. The work involved is minimal and there are a number of advantages, as follows:

1. The management has an up-to-date picture of the activities of the plant in respect to stock, sales and factor output.

2. For future reference and planning, a graph is available, which gives a quicker and clearer view than compiled figures.

3. Trends can be detected more easily from a graph than from figures.

Graph 7 is an example of a graph showing the activities during one season. Of course, the items included can be varied at will. If more than one type of product is involved, these additional items can be added.

Without going into too many details, the following remarks may be made on the example illustrated in the graph.

1. It is to be expected that dates will arrive at the packing house at a lower rate at the beginning of the harvest season than at the end, whatever the duration of the season may be. Only then the line X will have the S-form.

2. It is expected that the production line Z will show a lower rate in the beginning, due to the lower efficiency at the start of operations. Once the factory is working at full capacity, the line will soon become straight. The introduction of a time-saving machine, or the addition of one, may change the direction of this line.

3. The sales line is generally the most unpredictable. In Graph 7, which is arbitrary, initial sales were low, with consequently high storage requirements, indicated by the distance a-b, that is, a maximum of 500-110 = 390 tons. The graph shows, however, that after about 40 days, the sales curve was rising to such an extent that the factory output could not meet the demand (point P). The remainder of the dates could therefore only be sold at the rate the factory produced them. This may have resulted in a lower price.

4. Factory losses and graded-out dates have not been taken into account, because, in principle, they make no difference to the graph.

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Appendix 12

UNITED STATES STANDARDS FOR GRADES OF DATES [1,2]

Product description, styles, and grades

Sec.

52.1001 Product description.
52.1002 Styles of dates.
52.1003 Grades of dates.

Factors of quality

52.1004 Ascertaining the grade.
52.1005 Ascertaining the rating for the factors which are scored.
52.1006 Color.
52.1007 Uniformity of size.
52.1008 Absence of defects.
52.1009 Character.

Lot certification tolerances

52.1010 Tolerances for certification of officially drawn samples.

NOTE: This is the third issue of the United States Standards for Grades of Dates. These standards are issued by the Department after careful consideration of all data and views submitted. These standards were published in the *Federal Register* on 10 August 1955 (20 F. R. 5755). As in the case of other standards for processed fruits and vegetables, these standards are designed to serve as a convenient basis for sales, for establishing quality control programs, and for determining loan values. They will also serve as a basis for the inspection of this commodity by federal inspection service, which is available for the inspection of other products as well.

[1] United States Department of Agriculture, Agricultural Marketing Service, Washington, D.C. Effective 26 August 1955 (third issue). These standards supersede the standards which have been in effect since 20 October 1949.

[2] Complicance with the requirements of these standards shall not excuse failure to comply with the provisions of the Federal Food, Drug, and Cosmetic Act.

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Score sheet

52.1011 Score sheet for dates.
AUTHORITY: §§ 52.1001 to 52.1011 issued under sec. 205, 60 Stat. 1090, 67 Stat. 205; 7 U.S.C. 1624.

PRODUCT DESCRIPTION, STYLES, AND GRADES

§ 52.1001 *Product description*

Dates are the properly cured fresh fruit of the date tree (*Phoenix dactylifera*) which may or may not be softened by hydration. For the purposes of the standards in this subpart, dates, when referred to as " dry dates for processing, " means that the dates are dry and have not been softened by hydration.

§ 52.1002 *Styles of dates*

(*a*) " Whole " or " whole dates " means whole unpitted dates from which the pits have not been removed and which may be slit longitudinally.

(*b*) " Pitted " or " pitted dates " means whole dates from which the pits have been removed.

(*c*) " Pieces " or " date pieces " means dates that have been cut or sliced into small pieces and that can be handled as individual units.

(*d*) " Macerated " or " macerated dates " means dates that have been ground, chopped, mashed, or broken or that have been cut or sliced into small pieces and that cannot be handled as individual units.

§ 52.1003 *Grades of dates*

(*a*) " U.S. Grade A " or " U.S. Fancy " is the quality of whole or pitted dates that are of one variety, that possess a good color, that are practically uniform in size, that are practically free from defects, that possess a good character, and that score not less than 90 points when scored in accordance with the scoring system outlined in this subpart.

(*b*) " U. S. Grade B " or " U. S. Choice " is the quality of whole or pitted dates other than whole dry dates for processing that are of one variety, that possess a reasonably good color, that are reasonably uniform in size, that are reasonably free from defects, that possess a reasonably good character, and that score not less than 80 points when scored in accordance with the scoring system outlined in this subpart.

(*c*) " U. S. Grade B (Dry) " or " U. S. Choice (Dry) " is the quality of whole dry dates for processing that are of one variety, that possess a reasonably good color, that are reasonably uniform in size, that are reasonably free from defects, that possess a reasonably good character, and that score not less than 80 points when scored in accordance with the scoring system outlined in this subpart.

(*d*) " U.S. Grade C " or " U.S. Standard " is the quality of whole or pitted dates other than whole dry dates for processing that are of one variety or of date pieces or macerated dates that possess a fairly good color, that are fairly uniform in size except for date pieces or macerated dates, that are fairly free from defects, that possess a fairly good character, and that score not less than 70 points when scored in accordance with the scoring system outlined in this subpart.

(*e*) " U.S. Grade C (Dry) " or " U.S. Standard (Dry) " is the quality of whole dry dates for processing that are of one variety, that possess a fairly good color, that are fairly uniform in size, that are fairly free from defects, that possess a fairly good character, and that score not less than 70 points when scored in accordance with the scoring system outlined in this subpart.

(*f*) " Substandard " is the quality of dates that fail to meet the requirements of U. S. Grade C or U. S. Standard or U. S. Grade C (Dry) or U. S. Standard (Dry), whichever is applicable.

FACTORS OF QUALITY

§ 52.1004 *Ascertaining the grade*

In addition to considering other requirements outlined in the standards, the following quality factors are evaluated:

(*a*) *Factor not rated by score points*
  (1) Varietal requirement

(*b*) *Factors rated by score points*

The relative importance of each factor which is scored is expressed numerically on the scale of 100. The maximum number of points that may be given such factors are:

(1) Color	20
(2) Uniformity of size	10
(3) Absence of defects	30
(4) Character	40
Total score	100

§ 52.1005 *Ascertaining the rating for the factors which are scored*

The essential variations within each factor which is scored are so described that the value may be ascertained for each factor and expressed numerically. The numerical range within each factor which is scored is inclusive (for example, " 18 to 20 points " means 18, 19, or 20 points).

52.1006 *Color*

(*a*) (A) *classification*

Whole or pitted dates that possess a good color may be given a score of 18 to 20 points. " Good color " means that the color of the dates is practically uniform; and, with respect to dates that are predominantly light amber in color, there may be not more than 5 percent by count of dates that are dark amber in color; and, with respect to dates that are predominantly dark amber in color, there may be not more than 5 percent by count of dates that are light amber in color.

(*b*) (B) *classification*

If the whole or pitted dates or whole dry dates for processing possess a reasonably good color, a score of 16 or 17 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade B or U. S. Choice or U. S. Grade B (Dry) or U. S. Choice (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Reasonably good color " means that the color of the whole or pitted dates or whole dry dates for processing is reasonably uniform for the type; and, with respect to dates that are predominantly light amber in color, there may be not more than 10 percent by count of dates that are dark amber in color; and, with respect to dates that are predominantly dark amber in color, there may be not more than 10 percent by count of dates that are light amber in color.

(*c*) (C) *classification*

If the whole or pitted dates, whole dry dates for processing, date pieces, or macerated dates possess a fairly good color, a score of 14 or 15 points may be given. Dates that fall into this classification shall not be graded above U. S. Grade C or U. S. Standard or U. S. Grade C (Dry) or U. S. Standard (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). "Fairly good color " has the following meanings with respect to the following styles:

(1) *Whole; pitted*

The color of the whole or pitted dates or whole dry dates for processing is fairly uniform for the type; and, with respect to dates that are predominantly light amber in color, there may be not more than 20 percent by count of dates that are dark amber in color; and, with respect to dates that are predominantly dark amber in color, there may be not more than 20 percent by count of dates that are light amber in color.

(2) *Pieces; macerated*

The color may be variable throughout the units or mass, may be slightly dull but not offcolor, and is typical of properly prepared dates of these styles.

(*d*) (SStd) *classification*

Dates that fail to meet the requirements of paragraph (*c*) of this section may be given a score of 0 to 13 points and shall not be graded above Substandard, regardless of the total score for the product (this is a limiting rule).

§ 52.1007 *Uniformity of size*

(*a*) *General*

The factor of uniformity of size applies only to whole and pitted styles. The factor of uniformity of size in the styles of date pieces and macerated dates is not based on any detailed requirements and is not scored; the other three factors (color, absence of defects, and character as applicable) are scored and the total is multiplied by 100 and divided by 90, dropping any fractions to determine the total score.

(*b*) (A) *classification*

Whole or pitted dates that are practically uniform in size may be given a score of 9 or 10 points. " Practically uniform in size " means that not more than a total of 10 percent, by weight, of the whole or pitted dates may be conspicuously larger or smaller than the approximate average size of the dates in the container.

(*c*) (B) *classification*

If the whole or pitted dates or whole dry dates for processing are reasonably uniform in size, a score of 8 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade B or U.S. Choice or U.S. Grade B (Dry) or U.S. Choice (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Reasonably uniform in size " means that not more than a total of 15 percent, by weight, of the whole or pitted dates may be conspicuously larger or smaller than the approximate average size of the dates in the container.

(*d*) (C) *classification*

If the whole or pitted dates or whole dry dates for processing are fairly uniform in size, a score of 7 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade C or U.S. Standard or U.S. Grade C (Dry) or U.S. Standard (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Fairly uniform in size " means that not more than a total of 20 percent, by weight, of the whole or pitted dates may be conspicuously larger or smaller than the approximate average size of the dates in the container.

(*e*) (SStd) *classification*

Whole or pitted dates or whole dry dates for processing that fail to meet the requirements of paragraph (*d*) of this section may be given a score of 0 to 6 points and shall not be graded above Substandard, regardless of the total score for the product (this is a limiting rule).

§ 52.1008 *Absence of defects*

(*a*) *Definitions of defects*

Unless otherwise stated specifically, the following definitions of defects or defective units apply only to whole or pitted dates or whole dry dates for processing, as applicable for the type.

(1) " Damaged by discoloration " is the presence of a dark area in the flesh of the date, which dark area is visible through the skin and is more

than one-fourth ($^1/_4$) inch in width and extends more than the equivalent of half the length of the date, such darkening being of natural origin and not caused by mold or other organism.

(2) " Damaged by broken skin " is any rupture of the skin in a manner to expose the flesh of the date, the shortest dimension of such exposed area being not less than three-sixteenths ($^3/_{16}$) inch.

(3) " Damaged by checking " is the presence of fine lines, resulting from water injury, affecting the surface of the skin over an area not less than one fourth of the total surface of the date.

(4) " Seriously damaged by checking " is the presence of heavy lines, resulting from water injury, seriously affecting the surface of the skin over an area not less than one fourth of the total surface of the date.

(5) " Damaged by deformity " is any abnormal shape sufficient to produce an appearance discernibly at variance with the normal shape that is typical of the variety.

(6) " Damaged by puffiness " is the condition of a date of which the skin is soft and pliable and from which the skin is separated from the flesh in a balloon-like fashion, over an area not less than one half of the total surface of the date. Soft skins which have returned and adhere to the flesh of the date are not considered " damaged by puffiness. "

(7) " Seriously damaged by puffiness " is the condition of a date of which the skin is dry, hard, and brittle and from which the skin is separated from the flesh over an area not less than one half of the total surface of the date.

(8) " Damaged by scars " are any blemishes that affect the exterior of the date and which are not less than three-sixteenths (3/16) inch in the shortest dimension.

(9) " Damaged by sunburn " is an area, usually light in color, scarred by the heat of the sun, such area being not less than three-sixteenths ($^3/_{16}$) inch in the shortest dimension.

(10) " Damaged by insect injury " is any blemish, resulting from the activity of insects or mites, distributed over an area of not less than one fourth of the total surface of the date or any similar blemish that materially affects the appearance or edibility of the unit, regardless of the area affected.

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(11) " Damaged by improper hydrating " means that the date has been injured by excessive heat or that the hydrating process is incomplete.

(12) " Damaged by mashing " means any physical injury to the flesh and skin of the date leaving the date partially mangled but otherwise whole.

(13) " Damaged by mechanical injury " means excessive trimming or similar injury that damages the appearance or that damages or affects the eating quality of the whole date.

(14) " Damaged by lack of pollination " means, with respect to whole dates, that pollination of the date was not accomplished, such condition being manifested by the absence of a pit in the whole date or by thin, immature appearance of the date.

(15) " Damaged by blacknose " is severe checking in which the flesh becomes dark, crusty, and dry and which severe checking affects an area greater than one eighth of the total surface of the date.

(16) " Damaged by side spot " means a very dark area, which generally is circular in appearance, extending into the flesh of the date and, when decayed tissue or mold is not present, affecting in the aggregate an area not less than the area of a circle three-sixteenths ($^3/_{16}$) inch in diameter.

(17) " Damaged by black scald " means the collapse, death, and blackening of the flesh along the side of the date, usually accompanied by a bitter taste in the affected area.

(18) " Damage by improper ripening " means pronounced evidence of " green shrivel " of the date or that the date possesses a puffy flesh or a decidedly rubbery texture resulting from failure of the tissue of the date to reach a desirable state of maturity due to climatic or cultural injury, or both.

(19) " Damaged by other defects " means any injury or defect or group of defects not defined in this section (such as, but not limited to, heavy sugaring, and excessive scars not described in the definition " damaged by scars "), which materially affect the appearance, edibility, or keeping quality of the dates.

(20) " Affected by souring " is evidenced by the breakdown of the sugars into alcohol and acetic acid by yeasts and bacteria.

(21) " Affected by mold " is the presence of visible mold.

(22) " Affected by dirt " is the presence of any quantity of such substance.

(23) " Affected by insect infestation " is the presence of dead insects, insect parts, or excreta. (No live insects are permitted.)

(24) " Affected by foreign material " is the presence of any quantity of such substance.

(25) " Affected by decay " is a state of decomposition.

(*b*) (A) *Classification*

Whole or pitted dates that are practically free from defects may be given a score of 27 to 30 points. " Practically free from defects " means that in pitted dates there may be present not more than one whole pit or two pit fragments for each 25 ounces of pitted dates: and that the whole or pitted dates do not exceed the total allowances and limitations shown in Chart I of this subpart.

(*c*) (B) *Classification*

If the whole or pitted dates or whole dry dates for processing are reasonably free from defects, a score of 24 to 26 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade B or U.S. Choice or U.S. Grade B (Dry) or U.S. Choice (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Reasonably free from defects " means that in pitted dates there may be present not more than one whole pit or two pit fragments for each 25 ounces of pitted dates; and that the whole or pitted dates or whole dry dates for processing do not exceed the total allowances and limitations shown in Chart II of this subpart.

(*d*) (C) *Classification*

If the whole or pitted, dates, whole dry dates for processing, date pieces, or macerated dates are fairly free from defects, a score of 21 to 23 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade C or U.S. Standard or U.S. Grade C (Dry) or U.S. Standard (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Fairly free from defects " has the following meanings with respect to the following styles:

(1) *Whole*

The defects or defective units in whole dates or whole dry dates for processing do not exceed the total allowances and limitations shown in Chart III of this subpart.

(2) *Pitted*

Not more than one whole pit or two pit fragments for each 25 ounces of pitted dates may be present; and the defects or defective units in pitted dates do not exceed the total allowances and limitations shown in Chart III of this subpart.

(3) *Pieces; macerated*

Not more than one whole pit or two pit fragments for each 25 ounces of pitted dates may be present; and the units or mass consists of clean and sound date material, fairly free from defects that seriously affect the appearance, edibility, or keeping quality of the product.

(*e*) (SStd) *Classification*

Dates that fail to meet the requirements of paragraph (*d*) of this section may be given a score of 0 to 20 points and shall not be graded above Substandard, regardless of the total score for the product (this is a limiting rule).

CHART NO. 1

Allowances and limitations for defects in whole and pitted dates (other than whole dry dates for processing); U.S. Grade A or U.S. Fancy.

TOTAL ALLOWANCE	LIMITATIONS
Not more than a total of 10 percent, by weight of the dates, may be the following:	Not more than $^{3}/_{5}$ of the total allowance, or 6 percent, by weight of the dates, may be the following:
Damaged by:	Damaged by:
Discoloration	Side spot
Broken skin	Black scald
Checking	Improper ripening
Deformity	Other defects
Puffiness	
Scars	Affected by:
Sunburn	Souring
Insect injury	Mold
Improper hydrating	Dirt
Mashing	Insect infestation

TOTAL ALLOWANCE (*continued*)

- Mechanical injury
- Lack of pollination
- Blacknose
- Side spot
- Black scald
- Improper ripening
- Other defects

Seriously damaged by checking

Seriously damaged by puffiness

Affected by:

- Souring
- Mold
- Dirt
- Insect infestation
- Foreign material
- Decay

LIMITATIONS (*continued*)

- Foreign material
- Decay

Not more than $^2/_5$ of the total allowance, or 4 percent, by weight of the dates, may be the following:

Damaged by:

- Improper ripening
- Other defects

Affected by:

- Souring
- Mold
- Dirt
- Insect infestation
- Foreign material
- Decay

Not more than $^1/_{10}$ of the total allowance, or 1 percent, by weight of the dates, may be:

Affected by decay

CHART NO. 11

Allowances and limitations for defects in whole and pitted dates or in whole dry dates for processing; U.S. Grade B or U.S. Choice and U.S. Grade B (Dry) or U.S. Choice (Dry).

Not more than 15 percent, by weight of the dates, may be seriously damaged by checking.

Not more than 20 percent, by weight of the dates, may be damaged by broken skin.

LIMITATIONS

Not more than $^2/_3$ of the additional allowance, or 10 percent, by weight of the dates, may be the following:

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ADDITIONAL ALLOWANCE

Not more than a total of 15 percent, by weight of the dates, may be the following:

Damaged by:

- Deformity
- Puffiness
- Scars
- Sunburn
- Insect injury
- Improper hydrating
- Mashing
- Mechanical injury
- Lack of pollination
- Blacknose
- Side spot
- Black scald
- Improper ripening
- Other defects

Seriously damaged by puffiness

Affected by:

- Souring
- Mold
- Dirt
- Insect infestation
- Foreign material
- Decay

Damaged by:

- Lack of pollination
- Blacknose
- Side spot
- Black scald
- Improper ripening
- Other defects

Affected by:

- Souring
- Mold
- Dirt
- Insect infestation
- Foreign material
- Decay

Not more than $^1/_3$ of the additional allowance, or 5 percent, by weight of the dates, may be the following:

Damaged by:

- Improper ripening
- Other defects

Affected by:

- Souring
- Mold
- Dirt
- Insect infestation
- Foreign material
- Decay

Not more than $^1/_{15}$ of the additional allowance, or 1 percent, by weight of the dates, may be:

Affected by decay

CHART NO. III

Allowances and limitations for defects in whole and pitted dates or in whole dry dates for processing; U.S. Grade C or U.S. Standard and U.S. Grade C (Dry) or U.S. Standard (Dry).

TOTAL ALLOWANCE	LIMITATIONS
Not more than a total of 20 percent, by weight of the dates, may be the following:	Not more than ½ of the total allowance, or 10 percent, by weight of the dates, may be the following:
Damaged by: Deformity Scars Sunburn Insect injury Improper hydrating Mashing Mechanical injury Lack of pollination Blacknose Side spot Black scald Improper ripening Other defects	Damaged by: Lack of pollination Blacknose Side spot Black scald Improper ripening Other defects Affected by: Souring Mold Dirt Insect infestation Foreign material Decay
Seriously damaged by puffiness Affected by: Souring Mold Dirt Insect infestation Foreign material Decay	Not more than ¼ of the total allowance, or 5 percent, by weight of the dates, may be the following: Affected by: Souring Mold Dirt Insect infestation Foreign material Decay Not more than $^{1}/_{10}$ of the total allowance, or 2 percent, by weight of the dates, may be: Affected by decay

§ 52.1009 *Character*

(*a*) (A) *Classification*

Whole or pitted dates that possess a good character may be given a score of 36 to 40 points. " Good character " means that not less than 75 percent, by weight of the dates, are well developed, well fleshed, and soft, or at the time of packing are in a state of ripeness that within 15 days will develop into such character; and the remainder may possess a reasonably good character, including not more than a total of 2 percent, by weight of the dates, that may possess semidry calyx ends and none may possess dry calyx ends.

(*b*) (B) *Classification*

If the whole or pitted dates or whole dry dates for processing possess a reasonably good character, a score of 32 to 35 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade B or U.S. Choice or U.S. Grade B (Dry) or U.S. Choice (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule).

(1) " Reasonably good character " with respect to whole or pitted dates other than whole dry dates for processing means that the dates are pliable; that not less than 75 percent, by weight of the dates, are reasonably well developed and reasonably well fleshed, or at time of packing are in a state of ripeness that within 15 days will develop into such character and the remainder may possess a fairly good character including not more than 10 percent, by weight of the dates, that may possess semidry calyx ends and dry calyx ends: *Provided*, that not more than 2 percent, by weight of the dates, may possess dry calyx ends.

(2) " Reasonably good character " with respect to whole dry dates for processing means that the dates may be firm and dry; that not less than 75 percent, by weight of the dates, are reasonably well developed and reassonably well fleshed and that the remainder are fairly well developed and fairly well fleshed.

(*c*) (C) *Classification*

If the whole or pitted dates, whole dry dates for processing, date pieces, or macerated dates possess a fairly good character, a score of 28 to 31 points may be given. Dates that fall into this classification shall not be graded above U.S. Grade C or U.S. Standard or U.S. Grade C (Dry) or U.S. Standard (Dry), whichever is applicable, regardless of the total score for the product (this is a limiting rule). " Fairly good character " has the following meanings with respect to the following styles:

(1) *Whole ; pitted*

(*i*) In whole or pitted dates other than whole dry dates for processing, the dates may be firm but are pliable; may possess semidry calyx ends; and not less than 80 percent, by weight of the dates, are fairly well developed and are fairly well fleshed, or at time of packing are in a state of ripeness that within 15 days will develop into such character and the remainder may fail to possess such fairly good character or may possess dry calyx ends.

(*ii*) In whole dry dates for processing, the dates may be firm and dry but are fairly well developed and fairly well fleshed.

(2) *Pieces* ; *macerated*

The character may be variable throughout the units or mass but not seriously affected by dry calyx end material or inedible portions of dates.

(*d*) (SStd) *Classification*

Dates that fail to meet the requirements of paragraph (*c*) of this section may be given a score of 0 to 27 points and shall not be graded above Substandard, regardless of the total score for the product (this is a limiting rule).

LOT CERTIFICATION TOLERANCES

§ 52.1010 *Tolerances for certification of officially drawn samples*

When certifying samples that have been officially drawn and which represent a specific lot of dates the grade for such lot will be determined by averaging the total scores of the containers comprising the sample, if with respect to those factors which are scored:

(*a*) not more than one sixth of the containers fails to meet the grade indicated by the average of such total scores;

(*b*) none of the containers falls more than 4 points below the minimum score for the grade indicated by the average of such total scores;

(*c*) none of the containers falls more than one grade below the grade indicated by the average of such total scores; and

(*d*) the average score of all containers for any factor subject to a limiting rule is within the score range of that factor for the grade indicated by the average of the total scores of the containers comprising the sample.

Score sheet

§ 52.1011 *Score sheet for dates*

Size and kind of container	....
Container mark or identification	....
Label or brand	....
Net weight	....
Style	....
Count (per lb.)	....
Moisture content (if determined)	....
One variety (☐) Yes (☐) No	....

Factors	Score points			
Color	20	(A)	18–20	
		(B) (B-Dry)	[1] 16–17	
		(C) (C-Dry)	[1] 14–15	
		(SStd)	[1] 0–13	
Uniformity of size	10	(A)	9–10	
		(B) (B-Dry)	[1] 8	
		(C) (C-Dry)	[1] 7	
		(SStd)	[1] 0– 6	
Absence of defects	30	(A)	27–30	
		(B) (B-Dry)	[1] 24–26	
		(C) (C-Dry)	[1] 21–23	
		(SStd)	[1] 0–20	
Character	40	(A)	36–40	
		(B) (B-Dry)	[1] 32–35	
		(C) (C-Dry)	[1] 28–31	
		(SStd)	[1] 0–27	
Total score	100			
Grade				....

[1] Limiting rule.

The United States Standards for Grades of Dates (which is the third issue) contained in this subpart shall become effective 15 days after the date of publication hereof in the *Federal Register* and thereupon will supersede the United States Standards for Grades of Dates (7 CFR § 52.1001 to 52.1009) which have been in effect since 20 October 1949.

Dated: 5 August 1955. (SEAL) ROY W. LENNARTSON
Deputy Administrator
Marketing Services

Published in the *Federal Register*, 10 August 1955 (20 F.R. 5755).

Appendix 13

STANDARDS FOR GRADES OF ALGERIAN DATES TO BE EXPORTED

(Daglat Nuur and Common)

I. GENERAL REGULATIONS

ARTICLE 1. Shipment outside Algerian territory of dates not meeting the specifications set forth in the present decree shall be prohibited, and is subject to the conditions and sanctions provided for in Article 5 of the decree dated 23 December 1936.

ARTICLE 2. Only the designations approved by the present decree may be used, and they must be printed on each individual package inside the wrapping material. The shippers may add their trade-mark, as long as this does not bear any indication contrary to the regulations of the present decree. For shipment to foreign countries, these indications may be printed in the language of the importing country.

ARTICLE 3. Algerian dates for export are graded as follows:

Daglat Nuur Dates { for direct consumption
as picked

Common Dates[1]

The type must be indicated on each package.

II. DAGLAT NUUR DATES FOR DIRECT CONSUMPTION

ARTICLE 4. Daglat Nuur dates for direct consumption, both those direct from picking and those which have been processed, are graded as follows:

Daglat Nuur Dates " Extra "
Daglat Nuur Dates " Standard "
Daglat Nuur Dates " FAQ " (Fair Average Quality)

---

[1] All dates not of the Daglat Nuur variety.

ARTICLE 5. Daglat Nuur dates for direct consumption shipped under one of the categories in Article 4 must be ripe, healthy, whole, clean, fleshy, without malformations, parasites, diseases or serious damage caused by insects or bad weather. The sugar content must be at least twice the moisture content. The moisture content must not be over 30 percent.

ARTICLE 6. Daglat Nuur Dates " Extra. " Packages of Daglat Nuur Dates " Extra " must be homogeneous and must contain only dates weighing a minimum of 7 grams each.

Tolerance: 3 percent in weight of fruits not answering quality specifications; 3 percent in weight of fruits not answering weight specifications.

ARTICLE 7. Daglat Nuur Dates " Standard. " Packages of Daglat Nuur Dates " Standard " must be homogeneous and must contain only dates weighing a minimum of 6 grams each.

Tolerance: 6 percent in weight of fruits not answering to quality specifications; 6 percent in weight of fruits not answering to weight specifications.

ARTICLE 8. Daglat Nuur Dates "FAQ." Packages of Daglat Nuur Dates "FAQ" must contain only dates weighing a minimum of 6 grams each.

Tolerance: 10 percent in weight of fruits not answering quality specifications; 10 percent in weight of fruits not answering weight specifications.

ARTICLE 9. Packing. Daglat Nuur dates for direct consumption must be offered for sale in new packing of the following specifications:

(*a*) Daglat Nuur Dates " Extra " and " Standard "
Boxes from 1 to 10 kilograms each, cardboard boxes, metal boxes or mixed cardboard and metal, plastic boxes, cellophane wrappings, all put into cardboard or wooden boxes from 5 to 30 kilograms. The use of special packages required by the commercial regulations of importing countries shall be authorized. In the boxes and cellophane wrappings, the dates must be packed in rows and layers.

(*b*) Daglat Nuur Dates " FAQ "
Boxes from 20 to 30 kilograms each. Fruits of " Extra " and " Standard " quality must have between them and the sides of the boxes strong, clean and new paper. From 10 kilograms upward, all the boxes must be baled with at least two metal hoops across their width.

Article 10. Marks. All packages of Daglat Nuur dates for direct consumption must bear:

(*a*) indication as to contents and their origin: i. e., Algerian Daglat Nuur dates;

(*b*) the category: " Extra, " " Standard " or " FAQ ";

(*c*) net weight, except boxes of 30 kilograms called " Garden ";

(*d*) the packer's mark, as specified by the Office for the Suppression of Frauds, or his name and address. These marks must be inscribed clearly and legibly by means of indelible ink, or branded on the package in letters 2 centimeters high, or on a label firmly affixed on one of the sides of the boxes.

Article 11. Bunches of dates. Bunches of dates or parts thereof must be shipped in new boxes of any size. The package must bear the indication " Bunch of Algerian Dates " and the mark or complete name and address of the shipper, as laid down in Article 10.

III. Daglat Nuur dates as picked

Article 12. Dates direct from palm trees which have not undergone any treatment are graded according to their appearance, quality and weight in one of the following categories:

Daglat Nuur Dates " Ungraded "
Daglat Nuur Dates " Frezza "[1]

Article 13. Daglat Nuur Dates " Ungraded. " Under this designation come all dates which are healthy, whole, without parasites, diseases or serious damage caused by insects or bad weather. The fruit must be fleshy, weigh at least 6 grams each, and present no trace of fermentation. All crushed *Hashaj*[2] dates, *Coifi*, *Balah* or *Bisar*[3] dates shall be excluded from this category.

The packages may contain a maximum of 15 percent " Frezza " dates, corresponding to the specifications set forth in Article 14.

Tolerance: 10 percent in weight of dates not answering to weight or quality specifications.

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[1] Hard, dry dates.

[2] Shrivelled dates.

[3] Yellow or red, unripe dates.

ARTICLE 14. Daglat Nuur " Frezza. " Under this designation come all the dry Daglat Nuur dates which have reached full physiological development, with dry flesh, the skin adhering to the flesh, and crinkled, weighing at least 5 grams each.

Tolerance: 15 percent in weight of dates not answering to weight or quality specifications.

ARTICLE 15. Package. Daglat Nuur dates straight from picking must be got up in the following packages:

(*a*) Daglat Nuur Dates " Ungraded ": Boxes of 30 kilograms each, No. 32.

(*b*) Daglat Nuur Dates " Frezza ": Boxes of 30 kilograms each, No. 32, or clean and strong bags of a uniform size within the same batch. All the boxes must be baled with at least two hoops across their width.

ARTICLE 16. Boxes and bags of Daglat Nuur dates must bear:

(*a*) indication as to contents and their origin: i.e., Algerian Daglat Nuur dates;

(*b*) indication as to category: " Ungraded " or " Frezza ";

(*c*) the packer's mark, as specified by the Office for the Suppression of Frauds, or his name and address. These marks must be made clearly and legibly by means of indelible ink, or branded outside the package in letters 2 centimeters high.

IV. COMMON DATES

ARTICLE 17. Under the designation Common Dates come all dates of other than Daglat Nuur varieties, and which are ripe, fleshy, whole and clean.

The inclusion of bad fruits and all fruits which have not fully developed shall be prohibited. Mixing different varieties in the same package shall likewise be prohibited.

The Taffazouine, Rhars, Degla-Beida, Kentichi and Hmira varieties are the only ones whose export outside Algeria shall be authorized.

Tolerance: For each variety, a maximum of 10 percent of crushed, *bisar* or malformed dates shall be allowed.

ARTICLE 18. Common, Rhars or Taffazouine dates, prepared in the packing houses approved by the Office algérien d'action économique et touristique (OFALAC), of good quality, healthy, clean, without parasites, free from sand, may be presented whole or stoned, pressed or unpressed.

ARTICLE 19. Common dry dates may be packed in boxes of 30 kilograms each, No. 31, or in clean bags, strong and of a uniform size within the same batch. Fresh common dates shall be packed in 30-kilogram, No. 32 cases. The use of packages specified by the commercial requirements of the importing countries shall be authorized.

ARTICLE 20. Marks. All packages of Common Dates must bear:

(*a*) indication as to the contents, variety and origin, i.e., Algerian Kentichi dates;

(*b*) the packer's mark.

Boxes containing common dates must bear on their side a conspicuous colored stripe. This must not, however, obliterate or make illegible the above-mentioned marks.

V. DISINFESTATION AND OTHER DISPOSITIONS

ARTICLE 21. Before leaving Algeria, all the packages of Daglat Nuur dates for consumption must undergo disinfestation in the storehouses controlled or conducted by the Government Plant Protection Service.

ARTICLE 22. The officials of OFALAC, customs officials, those of the Office for the Suppression of Frauds and of the Plant Protection Service, are charged, each in their own field, with the application of the present decree.

ARTICLE 23. This decree cancels and replaces the previous decree of 12 November 1946 and all other dispositions to the contrary.

ARTICLE 24. The Secretary-General to the Government is charged with the execution of the present decree, which will be published in the *Journal officiel de l'Algérie.*

Appendix 14

REGULATIONS FOR THE STANDARDIZATION OF TUNISIAN DATES TO BE EXPORTED[1]

GENERAL REGULATIONS

I

The export of Tunisian dates not complying with the following regulations shall be prohibited and subject to the sanctions provided for in the decree of 19 July 1939.

II

Only the designations approved by this decree may be used; they must be printed on each package and on the packing materials. The shippers may add their trade-mark, provided this does not bear any indication contrary to the regulations of the present decree.

For shipment to foreign countries, these indications may be printed in the language of the importing country.

III

Dates for export are graded as follows:

Daglat Nuur Dates { for direct consumption
{ as picked

Alligh Dates

Common Dates

The type must be indicated on each package.

DAGLAT NUUR DATES FOR DIRECT CONSUMPTION

IV

Daglat Nuur dates for direct consumption, coming directly either from picking or from processing, are graded as follows:

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[1] Decree of the Ministry of Commerce and Handicrafts of 5 October 1949, establishing standardization regulations for Tunisian dates to be exported.

Daglat Nuur Dates " Extra "
Daglat Nuur Dates " Standard "
Daglat Nuur Dates " FAQ " (Fair Average Quality)

V

Daglat Nuur dates for direct consumption must be ripe, healthy, whole, soft-textured, clean, fleshy, without malformations, parasites, diseases or serious damage caused by insects or bad weather. The sugar content should be at least twice that of the moisture content. The moisture content must not be over 30 percent.

Weights and tolerances:

DAGLAT NUUR DATES " EXTRA "

VI

The contents of the packages must be homogeneous, and the dates must weigh a minimum of 7 grams each.

Tolerance: 3 percent in weight of fruits not answering to quality specifications; 3 percent in weight of fruits not answering to weight specifications.

DAGLAT NUUR DATES " STANDARD "

The contents of the packages must be homogeneous, and the dates must weigh a minimum of 6 grams each.

Tolerance: 6 percent in weight of fruits not answering to quality specifications; 6 percent in weight of fruits not answering to weight specifications.

DAGLAT NUUR DATES " FAQ "

Dates must weigh a minimum of 6 grams each.

Tolerance: 10 percent in weight of fruits not answering to weight specifications; 3 percent in weight of branches.

VII

Packing. Daglat Nuur dates for direct consumption must be offered for sale in new packing of the following specifications:

(*a*) Daglat Nuur Dates " Extra " and " Standard "
Wooden cases from 1 to 10 kilograms. Cardboard boxes, metal boxes, plastic boxes, mixed boxes, cellophane wrappings, all put into wooden

or cardboard cases from 5 to 30 kilograms, and any other packing required by commercial regulations of importing countries. In the boxes and packages wrapped in cellophane, the dates must be pressed. The fruits must have clean and strong new paper between them and the sides of the cases.

(*b*) Daglat Nuur Dates " FAQ "
Wooden cases of 20 and 30 kilograms. From 10 kilograms upward, all cases must be baled with at least two metal hoops across their width.

VIII

Marks. All packages of Daglat Nuur dates for direct consumption must bear:

(*a*) indication as to the contents and their origin, i.e., Tunisian Daglat Nuur dates;

(*b*) indication of the category: " Extra, " " Standard " or " FAQ ";

(*c*) the packer's house mark, as specified by the Office for the Suppression of Frauds, or his name and address. These marks must be inscribed clearly and legibly outside the packages in indelible ink, or branded in letters 2 centimeters high, or on a label firmly affixed on one side of the cases.

IX

Bunches of dates. Bunches of dates or parts thereof may be shipped in new cases of any size. The packing shall bear the inscription Bunches of Daglat Nuur Dates from Tunisia and the mark or complete name and address of the shipper, according to the regulations under Article VIII.

DAGLAT NUUR DATES AS PICKED

X

Dates coming directly from the palm trees and not having undergone any treatment are graded according to their appearance, quality and weight, in one of the following categories:

Daglat Nuur Dates " Ungraded "
Daglat Nuur Dates " Dry "

XI

Daglat Nuur Dates " Ungraded. " Under the designation Ungraded come all the dates which are healthy, whole, without parasites or serious damage caused by insects or bad weather. Fruits must be fleshy, weigh at least 6 grams each, and present no trace of fermentation.

Excluded from this category are all crushed dates, those without meat (*Hashab*) and unripe dates (*Balah* or *Bisar*).

The packages may contain a maximum of 15 percent " dry " dates, corresponding to the specifications set out in Article XII.

Tolerance: 10 percent in weight of fruits not answering to weight or quality specifications.

XII

Daglat Nuur Dates " Dry. " Under the designation Tunisian Dry come the dry Daglat Nuur dates which have reached full physiological development, with dry flesh, skin adhering to the flesh, crinkled, and weighing a minimum of 5 grams each.

Tolerance: 15 percent in weight of fruits not answering to weight or quality specifications.

XIII

Packing. Daglat Nuur dates as picked must be got up in the following packing:

(*a*) Daglat Nuur Dates " Ungraded. "
Cases of 30 kilograms called Garden.

(*b*) Daglat Nuur Dates " Dry. "
Cases of 30 kilograms called Garden, or clean and strong bags of a uniform size within the same batch.
All the cases must be baled with at least two hoops across their width.

XIV

Cases and bags of Daglat Nuur dates as picked must bear:

(*a*) indication as to the contents and their origin, i.e. Tunisian Daglat Nuur dates;

(*b*) indication of the category: " Ungraded " or " Dry ";

(*c*) the packer's house mark, as specified by the Office for the Suppression of Frauds, or his name and address. These marks must be inscribed clearly and legibly on the outside of the packages in indelible ink, or branded in letters 2 centimeters high.

ALLIGH AND KHOUAT ALLIGH DATES

XV

Quality and appearance. Alligh and Khouat Alligh dates for consumption must be ripe, healthy, whole, clean, fleshy, without malformations, parasites, diseases or serious damage caused by insects or bad weather. The sugar content should be at least twice the moisture content. The moisture content must not exceed 30 percent.

XVI

The dates must weigh a minimum of 6 grams each.

Tolerance: 6 percent in weight of fruits not answering to quality specifications; 6 percent in weight of fruits not answering to weight specifications.

XVII

Packing. Alligh and Khouat Alligh dates for consumption must be got up in wooden cases of 20 and 30 kilograms, baled with at least two hoops across their width.

However, Alligh and Khouat Alligh dates may be got up in cardboard boxes, metal boxes, plastic boxes or mixed boxes, cellophane wrappings, with the exception of the so-called " glove boxes."

Packages must be homogeneous. In the boxes and cellophane wrappings, the fruits must be pressed. The dates packed in this way may be prepared only in packing houses previously approved by the Office tunisien de standardisation (OTUS).

Any other packing required by the importing countries shall be authorized.

Marks. All packages of Alligh and Khouat Alligh dates must bear:

(*a*) indication as to the contents and their origin, i.e., Tunisian Alligh or Khouat Alligh dates;

(*b*) net weight, except for cases of 30 kilograms called Garden;

(*c*) the packer's house mark, as specified by the Office for the Suppression of Frauds, or his name and address. These marks must be inscribed clearly and legibly outside the packages in indelible ink, or branded in letters 2 centimeters high, or on a label firmly affixed on one side of the cases.

COMMON DATES

XVIII

Under the designation Common Dates come all those dates belonging to varieties other than the Daglat Nuur or Alligh and Khouat Alligh, and which are ripe, fleshy, whole and clean.

The inclusion of all fruits which have not reached complete physiological development, as well as bad fruits, shall be prohibited. Mixing different varieties in the same package shall likewise be prohibited.

Tolerance: For each variety, a maximum of 10 percent crushed, unripe or malformed dates shall be allowed.

XIX

Packing. Common dry dates may be packed in cases of 30 kilograms, or in clean, strong bags of a uniform size within the same batch.

Fresh common dates must be packed in cases of 30 kilograms each.

Any other packing required by the importing countries shall be authorized.

Common dates can also be presented whole, stoned or pressed, in small packs.

They must be of good quality, healthy, clean, without parasites, and free of sand.

They may be prepared only in packing houses previously approved by OTUS.

XX

Marks. All packages of common dates must bear:

(*a*) indication as to the contents, their variety and origin;

(*b*) the packer's mark;

(*c*) a red or black stripe on two sides of the boxes.

DISINFESTATION AND OTHER DISPOSITIONS

XXI

Before leaving the country, all packages of Daglat Nuur dates for direct consumption must undergo disinfestation in the storehouses approved, controlled or conducted by the services of the Ministry of Agriculture or by OTUS.

XXII

Packages of Daglat Nuur dates for direct consumption, and Alligh, Khouat Alligh and Common processed must contain a control slip delivered by OTUS and bearing the number of the exporter.

All packages must have the OTUS control label issued by that office.

Only packages containing Daglat Nuur " Extra " dates are required to bear the state mark label " Tunisia " issued by that office.

The small (individual) boxes of Daglat Nuur dates must bear the stamp " Tunisia " issued by OTUS.

XXIII

The decrees of 29 October 1947 and 2 November 1947 are revoked.

XXIV

The Director of the Office tunisien de standardisation is charged with the execution of the present decree.

Appendix 15

EXPLANATION OF WORDS USED IN THE DATE INDUSTRY

All foreign words are Arabic unless otherwise stated.

Transliteration from Arabic into Latin script is difficult, and no system used for it is entirely satisfactory. The one adopted here is very simple, but it represents a pronunciation only approximately correct.

The convention of doubling the long vowels has been adopted in order to avoid the use of the diacritical mark for the long vowel. Thus *a* has the sound of *a* in " hat, " while *aa* has the sound of *a* in " ask, " " cask " (as pronounced in the United Kingdom), etc.

No attempt has been made to indicate the Arabic letters, *hamza* and *ain*, because for a person who does not know that language, the usual way of representing them by signs is more confusing than helpful.

AAGINGIN	Dates in the green stage (Targi). Ghadames, Libya.
ABLUUH	Dates. A variant of *balah* (Marrakech, Morocco).
ABU HIZAAM	A date suffering from waist disease (Iraq).
ABUL KHUSHEIM	The meaning is the father of the little nose. Dry, hard Hallaawi (Basra) dates with base ivory colored, and apex shrivelled and reddish brown. The cause is complicated but is essentially physiological drought. A mild condition is called *Abu Nuqta*.
ABU NUQTA	A mild *Abul Khusheim* condition with the ivory-colored part restricted to a spot. The meaning is father of a spot.
ABYA	Date basket, Asid and Seiyuun (Hadhramaut, Aden Protectorate). From *aba* = to fill (a bag).
ADHAM	Date pit. Meaning is bone. Somalis also use the Somali word meaning bone (Libya and Marrakech, Morocco, where *alfa* is also used).

Adobado	Incubated. Dates ripened by vinegar (Spain).
Aghbaash	Variant of *Ghubaash*, q.v. (Libya).
Aghmag	*Kimri* (Gabès, Tunisia). A variant of *ghamag*.
Agwa (Ajwa)	Pitted *rutab*, dried in the sun and stamped into baskets (United Arab Republic). The *siim* of the Hadhramaut, the *ajiin* of Libya.
Ahaggaariiyan	Date (general word) in Targi.
Ahmar	"Red." In the United Arab Republic, also used for red *khalaal*. Variant also *asfar*, *balah*, *bisar*, *balah niiruz*.
Ajiin	Pressed, pitted dates (Libya). The *agwa* of the United Arab Republic and the *siim* of the Hadhramaut.
Ajma	Date pit (Hadhramaut, Aden Protectorate).
Ajwa	Variation of *agwa*.
Akhdhar	"Green." Derivatives, with the same meaning, are: *khadhar*, *khadhdhaar*, *khadhdhuuri*, *khadhraawi*, *khadhrai*, *khadhri*, etc.
Alfa	Date pit (Marrakech, Morocco). Also *adham*.
Amashhaut	*Rutab* in Berber.
Anag	Date cap (perianth). Iraq, Libya, Hasa, Saudi Arabia. Should be *unag;* also *anga*.
Ang-Eli	Drying platform for dates (Tibesti, Chad).
Ankariiz	*Hababauk* (Muscat and Oman).
Arabaana	In Iraq a cart or truck. In other places *araba*. Used in Basra for a truck for handling dates in a packing house.
Ariish	Dates of the coast of Libya, which do not ripen normally, but pass from the *khalaal* (*bisir*) stage to the dry date on the palm with little, or no, intermediate softening. Cf. the *chasib* of northern Iraq. (Original meaning: an arbor or a support for a vine.)
Arjuun	The date bunch (Libya). The *ithik* (corruption of *ithkaal*) of Iraq.
Arsa	*Kimri* in Teda (Kufra, Libya).

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Asal or Asal Sahh	(Muscat) *asal sahh* = date syrup. *Asal nahal* = honey. Variation *dibis.*
Asfar	Yellow. In the United Arab Republic used for yellow *khalaal.* See also *ahmar, balah, bisir, balah niiruz.*
Asqa	1. The main stem of a date bunch. 2. The dry date bunch after the removal of the dates (Iraq).
Aveina	*Tamar* or generic term for date (Ghadames, Libya) in Berber. Dates = *veinaawan.*
Baariya	In Iraq a mat woven from split reeds and much used in temporary date-packing houses for making shelters from the sun, for keeping dates off the ground, and for covering dates against sun or dew.
Badaar	Circular, rush mat, used, among other things, for drying dates (coast of Libya). Plural *badaaraat.*
Bahaar	A measure of weight of 300 *ratal* = about 400 kilograms, southern and eastern coasts of Arabia.
Balah	General term for dates in any stage (United Arab Republic); frequently in literature. In Libya means *khalaal*, but see note under *bisir.* In Tunisia and in Hejaz (Saudi Arabia) means *khalaal.* In French literature often *blah.*
Balah Bisir	*Khalaal.* Same as *balah niiruz* (United Arab Republic). Variation also *ahmar* and *asfar* (see also *bisir*).
Balah Naashif	Hard, dry dates (e. g., Gundeila and Sukkanti) United Arab Republic.
Balah Niiruz	*Khalaal.* Same as *balah bisar* (United Arab Republic). Variation also *ahmar* and *asfar.*
Balah Rutab	*Rutab* (United Arab Republic).
Ballaas	(*Plural balaaliis*). Earthenware jar (United Arab Republic).
Banad	The thread or string made from the split main axis of the date bunch. Used for sewing up the matting strip to make date baskets, etc. (Iraq).

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BANJ	Anaesthetic, etc. Used in date-packing houses for fumigant.
BARSIIL	Basket for storage of dates (Libyan coast), of date palm leaflets or, more commonly, of esparto grass.
BATH	Loose dates (Libya).
BHUGRIAN	*Khalaal matbuukh*, but not cut (Lyallpur, Pakistan).
BHUUGAARI	*Khalaal matbuukh*, but not cut (Muzaffargarh, Pakistan).
BIDI	Mummified date (Niger).
BINT EL-BAARIHA	Fully *rutab* (Yemen).
BISIR	In Iraq, *bisir* means first fruits of any fruit but is not usually applied to dates. In Bahrein and Hasa (Arabia) *bisir* means *khalaal*. In Libya *bisir* also generally means any *khalaal*, but in parts of the country *balah* means *khalaal* when it is just colored, and *bisir khalaal* when the color has deepened. More commonly in Libya the terms *bisir* and *balah* are used indiscriminately. *Safar* is also used.
BLAH	See *balah*.
BU FARWA	Web spun by mites on dates (Sahara). Meaning father of fur.
BUNQUE	Circular bin of matting for the field storage of dates (Baja California, Mexico).
BURSH	In the United Arab Republic the mat on which the dates are trampled into a paste.
CANDIOS	Mummified dates (Spain).
CHARDAAGH	A shelter of mats supported on poles, used as a temporary date-packing house on the banks of Shatt el-Arab, Iraq. Possibly from the Persian *chahaar diirak* (four poles).
CHATTI	Earthenware jar (Punjab).
CHELOFAAN	Cellulose film, Iraq and Libya.

Chasib	Classically, *qasb*. Light-colored dates of several varieties (e.g., Zahdi and Ashrasi) of northern Iraq, which do not ripen normally but pass from the *khalaal* stage to the dry date on the palm, with little or no intermediate softening. Cf. the *ariish* of the coast of Libya and the *faraz* of Algeria.
Cheirkhaana	Stove for cooking *khalaal matbuukh* (Muscat). Also called *tinkba.*
Chimri	So pronounced in Iraq and Khuzistan (Iran). See variation *kimri.*
Chiirwaan	*Khalaal matbuukh* but cut in two before boiling (Muzaffargarh, Pakistan).
Chirvi	*Khalaal* split in half and sun dried (Muzaffargarh, Pakistan). Also called *shingistan.*
Chhohaara	*Khalaal matbuukh* (Lyallpur, Pakistan). Also called *chhoaara.*
Chuptagen Kulont	Dates of the Sabzo variety, cut (sliced) into small pieces and preserved in syrup (Panjgur, Makran, Pakistan).
Chuwarar	*Khalaal* (Sind, Pakistan).
Colache	Jelly made by boiling down date syrup (Mexico).
Danagi	Unpitted date paste pressed into baskets or skins (Panjgur, Makran, Pakistan). Cf. *kabiis.*
Dang	Half *khalaal* and half *rutab* (Muzaffargarh, Pakistan).
Dastlagash	Paste of dates from which pit, cap and skin have been removed (Makran, Pakistan).
Daukaa	*Kimri and khalaal* (Lyallpur, Pakistan).
Dhubdhub	*Hababauk* (Hadhramaut, Aden Protectorate).
Dibis	More correctly *dibs*. From *dabasa* = to become sweet (grapes, etc.). Date syrup (Iraq) = *asal sahh* (Muscat) = *hall* (Makalla) = *qutaara* (Aden) = *rubb* or *asal* (Libya) = *rubb* or *seilaan* (Iran).
Dira	Drying ground for dates (Hadhramaut coast, Aden Protectorate).

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DOKA	*Khalaal* (Pakistan, Punjab).
DUFEIQ	*Kimri* (Sudan).
DURRA	Means pearl. *Hababauk* (Hasa, Arabia).
DUUM PALM	*Hyphaene thebaica* Mart. (Djibouti, Sudan, Tibesti, etc.). The northern limit of the Duum (French *doum*) in Africa roughly corresponds with the southern limit of the date.
FADHA	*Khalaal* (Hadhramaut, Aden Protectorate).
FARAZ	See *chasib*, *farza*, *frezza*.
FARD	The basket into which the date paste is pressed (United Arab Republic). *Zanbiil*, *ganba* and *qafas* also used. Means single.
FARSALA	Large date basket of the Gulf of Oman and the Hadhramaut coast.
FARWAND	Climbing belt (Iraq and Khuzistan, Iran).
FARZA (plural FARAZ)	Dry or mummified date. The term is used especially in the Daglat Nuur trade in North Africa. The *frezza* of the French literature. Cf. the *abul khusheim* type of the Basra Hallaawi and the *qasb* (*chasib*) used for the dry Ashari and for other dry Baghdad dates and the " bread dates " of the American literature.
FARZUUN	Green date (Taworgha, Libya).
FASMA	A date stone (Iraq).
FREZZA	Mummified Daglat Nuur (Algeria). Variation *farza*.
GAARIS	Slightly fermented (dates or other things). Libya.
GABBAAN	Weighing machine (Iraq).
GABBANCHI	The man in the Basra date-packing houses who weighs the dates. *Gabbaan* plus the Turkish termination -chi or -ji, meaning doer or operator.
GAMA	Date cap (perianth). (Hasa, Saudi Arabia and Bahrein). Also pronounced *guma* (Hasa and the United Arab Republic). Pronounced also *qaama* (Muscat).

Ganba	(Pronounced *gamba*). Packing basket (United Arab Republic). See also *qafas* and *zanbiil.*
Gandora	*Kimri* and *khalaal* (Muzaffargarh, Pakistan).
Garko	Small basket in which the *dastlagash* date paste is pressed. (Kech, Makran, Pakistan). Cf. *pachak.*
Gausara	Date basket (Hadhramaut coast, Muscat, Persian Gulf coast and Basra). From *qasura* = to be short.
Ghamag	*Kimri* (Libya, coast).
Gharbaala or Gharbiil	Sieve for all purposes, also one for dates, also wire tray for dates. Should be *ghirbaal* (Iraq, Libya).
Ghubaar	Dust. The web spun on dates by mites (Iraq). The *bu farwa* of Algeria and the *ghubaash* of Libya.
Ghubaash	Corruption of *ghubaar*, dust. The web spun on dates by mites (Libya). The *bu farwa* of Algeria and the *ghubaar* of Iraq.
Gishir	Skin. Can be used for date skin. Should be *gishr.*
Grogs	*Khalaal* (Spain).
Guffa	Basket, of various kinds. One kind used commonly for carrying dates (Iraq).
Guma	Perianth. Variation *gama.*
Habaabau	*Hababauk* (Bahrein).
Hababauk	Dates in their earliest stage from pale cream to faintly green before they become *kimri* (Iraq). Cf. the *habaabau* of Bahrein.
Habal	Rope. Can be used for rope made of *liif*, the fiber of the date palm, which has many uses in date gardens and temporary date-packing houses.
Habambuk	*Hababauk* (Hasa, Saudi Arabia).
Hadhiira	Fence of palm fronds round a Muscat date-drying ground.
Halfa	A coarse, tall grass in Iraq (*Andropogon*). Used, among other things, for lightly covering *khalaal matbuukh* during drying.

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HALL	Date syrup (Makalla, Hadhramaut coast, Aden Protectorate). Variation *dibis.*
HALLAANA	Variation *khasaafa.*
HARAG	Boiled and dried *khalaal* (Makran, Pakistan). The *khalaal matbuukh* of Iraq.
HASHAF	Shrivelled green dates caused by severe water shortage or by damage to spikelet or bunch on which borne (Iraq). Singular *hashafa.*
HASHSHAAF	The boy in a temporary date-packing house on the Shatt el-Arab whose duty is to collect the refuse dates, consisting largely of *hashshaf,* from the boxes beside the grading women and to tip it onto a heap, whence they will be disposed of for cattle food.
HASIIR	A mat of rush or other materials. Used, among other things, for spreading on the ground underneath heaps of dates (Libya, etc.).
HIKMA	Basket of date palm leaflets, Darj, Libya.
HINZAK	Skins in which dates are packed (Makran, Pakistan).
HUMB	Unglazed, earthenware jar for preserving dates (Makran, Pakistan and Punjab).
HUMEIRA	A small, spherical date that has dried. It may be still attached to the spikelet or held in the bunch between the other dates, or fallen to the ground. The green skin turns Venetian red and is brittle. The flesh dries and shrinks away from the skin. Caused by June drop or by the attack of the Lesser Date Moth. Has to be graded out (Iraq). Also called *tujeij* or, in Bahrein, *khafaar.*
HURMAG	*Tamar* (Panjgur, Makran, Pakistan).
INDHUUKAN	*Hababauk* in Targi (Ghadames, Libya).
ITHIG	A corruption of *ithkaal.* A bunch of dates (Iraq). The *arjuun* of Libya.
JARAB	Scab, rust, blemish. In connection with dates, *Parlatoria* scale (Libya and elsewhere). The *jidri* of Iraq.

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JARBA	(Plural *jaraabi*). Skin (Iraq) for storing dates, irrigating palms, etc. Classically *qirba*.
JAUKHAAN	Date-collecting station in a garden (Iraq and Khuzistan, Iran). The *shuuna* of the Sudan. The *dira* of the Hadhramaut coast. Obviously derived from the Persian; meaning the house, or room of the place.
JIDRI	Smallpox. In connection with dates. *Parlatoria* scale (Iraq and elsewhere); the *jarab* of Libya.
JILID	Classically *jild*. A skin used for storing dates or for other purposes. Plural *juluud*.
JILLA	Large, soft basket of date palm leaflets. Used largely for the transport of loose dates in Iraq and Bahrein. Should be *julla*. Plural *jilaal*.
JIMRI	*Kimri* (Bahrein). Also called *khalaal*.
JIRAAB	Date basket, Harshiyaat (Hadhramaut, Aden Protectorate). Original meaning a leather bag.
KAATIB	A clerk. The supervisor of a temporary date-packing house on the banks of the Shatt el-Arab (Iraq and Iran).
KABAS	From *kabasa* = to press. Hence pressed, that is, packed dates. The *chibis* of Iraq.
KABIIS	Pressed, unpitted dates (United Arab Republic).
KARR	Belt for climbing date palms (Bahrein).
KHAABIYA	Earthenware jar for dates, etc. (Libya). Circular, plaster bins for dates (Oued Souf, Sahara). Plural *khawaabi*.
KHAARAK and KHARAAK	*Khalaal matbuukh* (shore of Persian Gulf, Iran).
KHAFAAR	June drop dates (Bahrein). Variation *humeira*.
KHAIYIS	Rotten (of dates, etc.) (Iraq).
KHAJJI	Date (Pakistan, Punjab).
KHAJUUR	Date (Pakistan, Punjab).
KHALAAL	This is the *balah* or *bisir* of North Africa. Dates in their fully grown, hard, glossy, yellow (or red) stage

	after they have ceased to be *kimri* and before they have become *rutab*. (Iraq, and used in the United States. In Bahrein, Hasa and Oman (Arabia) *khalaal* means *kimri*.)
Khalaal Matbuukh	*Khalaal* cooked and dried (Iraq) = *Saluuq* (Bahrein and Hasa).
Khamal	*Kimri* (Pakistan, Punjab).
Khariif	In Arabic means autumn, with fresh dates, *khalaal*, as a secondary meaning. In Somali means the south-east summer monsoon, its dry, hot wind, and also the dates which are then in the *khalaal* stage (Somalia).
Khasaafa	The palm leaflet basket in which dates are field-packed in Iraq. From *hasafa* = he sewed. Also called *hallaana*.
Khurma	Date (Pakistan, Punjab). *Tamar* (Pakistan, Punjab).
Khuusa	Leaflet of date palm (Iraq). In Libya called *saafa*. Plural *khuus*.
Kimri	Dates in the green stage (Iraq and United States). In Iraq generally pronounced *chimri*, in Bahrein *jimri*.
Kuk or Kukan	Mummified date (Muzaffargarh, Pakistan).
Kulont	*Khalaal*. Same as *rang* (Makran, Pakistan).
Kunchi Tohrag	Powdered *khalaal matbuukh* mixed with fried sesame seed (Makran, Pakistan).
Laagbi	The sap of the date palm either fresh (*halu*) or fermented (*gaaris*). (Tunisia, Libya and United Arab Republic.)
Laagmi	(Tunisia) = *laagbi*.
Laghati	Pitted date paste (Kech, Makran, Pakistan). Cf. the *agwa* of the United Arab Republic.
Laham	Meat or flesh. Also used for flesh of date.
Lar	Dried dates of the Muzati variety cut in two horizontally and threaded on strings (Panjgur, Makran, Pakistan).

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MADBASA	*Mudibsa.* Rectangular field store for dates in Basra with mud walls and plastered, ribbed floor and channel to conduct syrup to tin outside. Open top or covered with palm fronds or mats, or mudded. Plural *madaabis.*
MADUROS	*Tamar.* Same as *negros* (Spain).
MAGLAS	Crutched stick attached to rope and on which dates are lowered to ground (Iraq).
MAKBUUS	Pressed and hence, until the advent of modern packing houses, packed. Applied to dates as well as to other things.
MAKHTAF	Crutched stick used for lowering dates from palm (Libya).
MALWI	Shrivelled (dates) (Iraq).
MAMRUUD	Squashed (dates and other things). Iraq. From *marada* = he mashed.
MANGUUB	Holed (dates or other things). (Iraq). From *nagaba* = to pierce.
MANN	A measure of weight in the Near and Middle East, varying from place to place. The date *mann* of Hasa weighs about 240 kilograms, that of Iraq 70 or 72 kilograms, and that of Muscat about 4 kilograms. The standard *mann* of Pakistan weighs a little over 36 kilograms.
MANSHARA	Drying ground for dates (United Arab Republic).
MARATBA (MARTUUBA)	(Both singular). In French literature. *Rutab* (Algeria).
MARBATA	Climbing belt (Hejaz, Saudi Arabia). Meaning that which is tied.
MARHALA	Long, wide, squat basket of woven date palm leaflet used for transport and storage of dates (Muscat and Oman). From *rahala* = to remove.
MARKADH	Climbing belt (Yemen).
MARZUUM	Pressed dates (Hadhramaut, Aden Protectorate). From *razama* = to pack.

MASJAL	Pot for cooking *khalaal matbuukh* (Muscat).
MASTAH	Also *mustaah*. From *sataha* = he spread out dates to dry. The drying ground (Muscat).
MATMAR	Pit in sand in which dates are stored (Fezzan). Plural *matamiir*.
MAZARI	Dwalf palm (*Nannorrhops ritchieana* H. Wendl.) of Baluchistan, whose leaflets are woven for date baskets.
MINGAAR	(Libya). Date cap (perianth). The original meaning is bird's bill. Also *anag*, *kadhanu*, *naghfa*, *tafarshit* and *taasart*.
MISFAA	A strainer. With respect to dates, the strainer with which the *khalaal matbuukh* are removed from the boiling water (Basra, Iraq).
MIS-HA	Spade (Iraq), hoe (Libya). The hoe is used for many agricultural purposes, including removing the sand from above the dates in the *matmar* (pit).
MISHAAN	Fresh dates, also the cylinder made of palm midribs in which they are transported (Muscat and Oman).
MUDAUBAG	Sticky. Can be used for sticky dates. In Iraq pronounced *mudaubaj*.
MUDIBSA	Variation *madbasa*.
MUHEILA	Wooden lighter at Basra, Iraq, for river transport. Used, among other things, for the transport of dates from the packing houses to the ships waiting in midstream.
MUKAUWA	Cardboard or fibreboard.
MUKHANNAN	Term applied in Iraq to dates suffering from pinched and shrivelled apex. Perhaps a similar condition to the "blacknose" of California. From *makhanna* = a nose.
MUNAASIF	Half *khalaal* and half *rutab* (Yemen).
MUNAKKAZ	(Dates) with hard, lunar patch on skin caused by Lesser Date Moth attaching at that place the silken cord that holds the date, into which it intends to burrow, from falling. From *nakaza* = to prick.

Murattab	*Rutab* is the simple noun and adjective, while *murattab* is the passive participle of the second measure of the verb. As far as dates are concerned, the meaning is the same. The former is the general word; the second is used in Algeria.
Musauwas	Infested by *suus,* that is, by small insects, mature or immature, or by their excreta, silk, etc. (Iraq).
Na	*Tamar* (Kech, Makran, Pakistan).
Nabaata	Date cap (perianth) (Marrakech, Morocco).
Naghfa	Date cap (perianth) (Sabha, Libya).
Najidh	Mature. Applied in the Sudan to the product obtained by drying *khalaal* in the sun.
Najjaar	A carpenter. In the Basra (Iraq) date-packing houses the man who nails up the shooks and lids the packed boxes.
Nakhara	Date cap (Sudan). Also *nagruuma* and *qaar*.
Naqadh	*Kimri* (Hadhramaut, Aden Protectorate).
Nawaiya	Date pit (Libya and Iraq). Also seedling date palm.
Negros	*Tamar*. Same as *maduros* (Spain).
Nuseifi	A *khasaafa* (q. v.) holding half a *mann* (36 kilograms), Iraq. From *nusuf* = half. Plural *nuseifiyaat*.
Nusf Wa Nusf	Usually corrupted into *nus wa nus* = half and half. Dates with basal half *khalaal* and apical half *rutab*.
Pachak	See *garko*.
Pappuk	*Kimri* (Makran, Pakistan).
Pappuk Rekiwar	Inferior *khalaal* made from *kimri* ripened on the hot sand (Makran, Pakistan).
Parbun	Climbing belt (Panjgur, Makran, Pakistan).
Parwan	Climbing belt (Bushire, Iran).
Pat	Basket into which dates are stamped (Panjgur, Makran, Pakistan).

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Pend	*Rutab* (Muzaffargarh, Pakistan).
Pind	*Tamar* (Muzaffargarh, Pakistan).
Qaaar	Date pit (Sudan). Also *nagruuma* and *nakhara.*
Qaalib	A form or mold used for packing dates, etc.
Qaanuub	Date cap (Hadhramaut, Aden Protectorate).
Qafas (or Gafas)	Packing basket (United Arab Republic). See also *zanbiil* and *ganba.*
Qara	*Rutab* (Hadhramaut coast, Aden Protectorate).
Qazzi	Date pit (Djibouti, Côte française des Somalis). Possibly a Yemeni word.
Qirba	A skin. Used for water, also for dates, etc. In Iraq it is called *jarba.*
Qudar	*Khalaal* in Teda (Kufra, Libya).
Qunt	Date cap (perianth) (Tunisia).
Quseiba	Circular, mud, field storage bin for dates (Sudan). Plural *qusaiyib.*
Qutara	Date syrup (Aden Protectorate). Variation *dibis.*
Rang	*Khalaal.* Same as *kulont* (Makran, Pakistan).
Rubb	Date syrup (Libya, Iran). Variation *dibis.*
Rukk	Stiff basket made of the midribs of date fronds and used for carrying dates, etc. (Iraq). Plural *rukuuk.*
Rutab	Means wet. Used in most of the Arab part of the date-growing world and in the United States for dates in their soft stage, between *khalaal* and *tamar. Qara* (Hadhramaut coast).
Saafa	In Iraq, date palm frond. In Libya, date leaflet.
Sadi	*Kimri* (Hejaz, Saudi Arabia).
Safar	*Khalaal* (Libya, coast). Not much used. Original meaning yellow. See also *bisir.*

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Safiif	The narrow strip of matting out of which the baskets for packing dates are made (Iraq). From *saffa* = to weave palm leaflets.
Saga	In Libya = cold. Presumably a Berber word. Can be applied to a variety of date of which a large quantity can be eaten without giving rise to a feeling of discomfort.
Sahh	Dates generally (Muscat and Oman).
Salla	Big, pliable, date leaflet basket for carrying, among other things, loose dates from the palm to the *jaukhaan* at harvest (Iraq).
Saluuq	*Khalaal matbuukh* (Bahrein and Hasa, Saudi Arabia). Means boiled.
Sama	A mud bin for storing dates, wheat, etc. (United Arab Republic).
Sarampag	(Also *srumpag*). Date cap or perianth (Makran, Pakistan).
Seilaan	Date syrup on Shatt el-Arab, but *dibis* is commoner name.
Senugu	Goatskin (Teda).
Sharmuukh	(Iraq) Corruption of *shumruukh*, q.v.
Shariit	Twine made of twisted date palm leaflets for sewing up date baskets, etc. (Iraq).
Shataf	Date basket (Gheil Umar, Hadhramaut, Aden Protectorate).
Sheil Meiyit	The bearer of the dead, the man who in the temporary date-packing house in Basra, Iraq, carries the boxes of packed dates from the women packers to the weighing machine.
Shiira	Date syrup. A Persian word.
Shiis	Unfertilized dates (Iraq). Cf. *siis*.
Shingistan	*Khalaal* cut in half and dried in the sun (Muzaffargarh, West Pakistan).
Shumruukh	The spikelet of a date bunch. In Iraq corrupted into *shamruukh* or *sharmuukh*.

SHUUNA	Garden, date-collecting station (Sudan). *Jaukhaan* in Iraq.
SIIM	Pitted date paste. (Hadhramaut, Aden Protectorate). The *agwa* of the United Arab Republic.
SIIS	Unfertilized dates (North Africa). Cf. *shiis* and *shiish.*
SORAPAG	Beaten *kimri* (Makran, Pakistan). Original meaning sour water.
SRUMPAG	(Also *sarampag*). Date cap (perianth). (Makran, Pakistan)
SUFUURI	*Khalaal* (Sudan). From *asfar* = yellow.
SUHH	*Tamar* (Muscat and Oman).
SUKKI PEND	*Tamar* (Lyallpur and Muzaffargarh, Pakistan).
SUND	Jar-shaped basket put over bunch of dates to catch dates that would otherwise fall (Makran, Pakistan, and Baluchistan, Iran).
SUNDUUQ	In Iraq pronounced *sanduuq*. A box. A third of Iraq's export of dates and a fifth of that of Iran is made in wooden boxes. Plural *sanaadiig.*
TAAQIIM	Drying, dehydration.
TABNIIJ	Fumigation. Variation *banaj.*
TADAGHSHIIN	Web spun by mites on dates. Berber (Ghadames, Libya). *Ghubaar* (Arabic).
TAFARSHIT	Date cap (perianth). (Ghadames, Libya). A Berber word.
TAFARUUQA	Date cap (perianth). Muscat. Also *qaama.*
TAFRIID	Separation. As applied to dates, the separating of date bunches from each other and from the fronds when dates are half grown. During this operation many of the refuse dates are shaken to the ground.
TAJFIIF	Drying, dehydration.
TALLO	Haleni and Begum Jangi dates cut in two lengthwise and preserved in jars (Kech, Makran, Pakistan).

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TAMAR	The generic term for dates. Dates in the fully ripened, prune-like stage. In all the Arab date-producing countries, except the United Arab Republic, where *balah* is more usual.
TAMMAAR	The man whose duty is to keep the women supplied with dates (*tamar*) in a Basra date-packing house.
TARGI	The language of the Tuwaarig. Allied to Berber.
TEDA	The language of the Tibbu, a Hamitic people of southern Libya and the Chad.
TEINI	General name for dates (Ghat, Libya). Targi word.
TEIRAGHI	*Khalaal* in Targi (Ghadames, Libya).
THAUB	Paper-like endocarp covering pit in date (Iraq). Literally gown.
TIMMI or TINNI	*Tamar* (Niger). Also dates generally.
TINE	*Tamar* in Teda (Kufra, Libya). Also general word for date.
TINKBA	Stove for cooking *khalaal matbuukh* (Muscat). Also called *cheirkhaana*.
TINNI	*Tamar* and dates generally (Niger).
TOR	Climbing belt (Kech, Makran, Pakistan).
TUJEIJ	June drop dates (Iraq). Small, spherical dates with red, brittle, paper-like skin. The same as *humeira* and as the *khafaar* of Bahrein.
TULEI	*Rutab* in Teda (Kufra, Libya).
TULI	*Khalaal* (Niger).
UGLA	The communal collection of pits in the sand in which dates are stored (Fezzan).
UMEIR	Frass.
UMM NUS	For *umm nusf* (the mother of the half). Dates half *khalaal* and half *rutab* (Sudan).
UUGDA	*Rutab* in Targi (Ghadames, Libya).

VEINAAWAN	Dates (Berber, Ghadames, Libya). Singular *aveina.*
VERDE	*Kimri.* Means green. Spain.
WAAA	Date basket (Waadi Hajar, Hadhramaut, Aden Protectorate) From *wiaa* = a bag.
WAGGAAF	An overseer in a date-packing house (Basra, Iraq).
WASLA	Belt for climbing date palms, meaning that which causes one to arrive (Libya).
WASAM	*Rutab* (50 percent). (Hadhramaut, Aden Protectorate).
ZANBIIL	Written in Arabic *zanbiil* but pronounced *zambiil.* Packing basket in the United Arab Republic. See also *ganba* and *qafas. Zanbiil* in Iraq is a small, pliable basket used, among other things, for collecting dates during harvest. The *zanaabiil*, when full, are emptied into the big *sallaal* (singular *salla*), or carrying baskets.
ZIIR	Unglazed, earthenware jar in which dates, etc., are stored (Sudan). Plural *ziyaar* or *azyaar.*

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P-17
Sagraf - Napoli
ISBN 92-5-100456-0